Custer National Forest

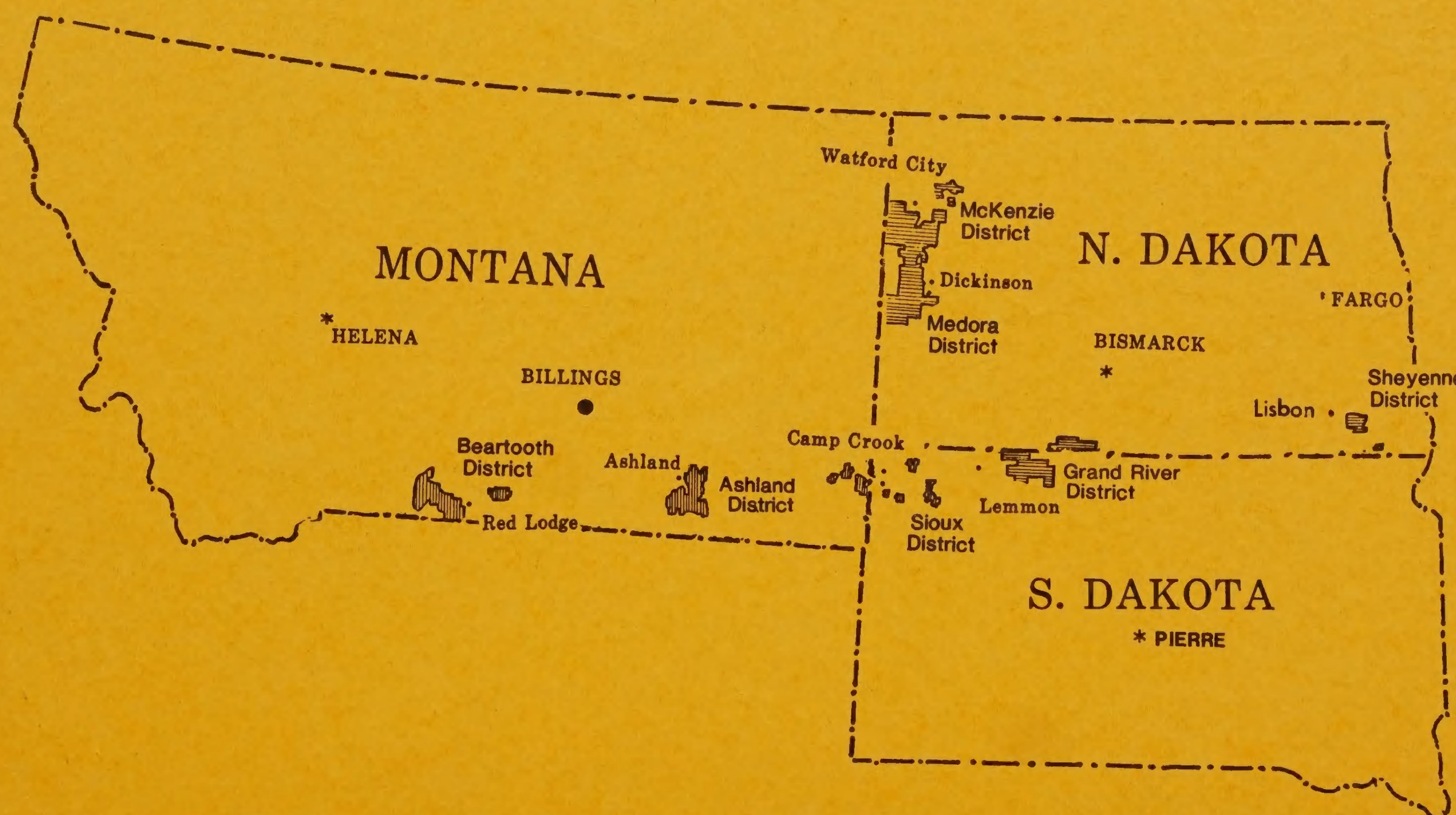
noxious weed treatment program



DRAFT Environmental Impact Statement

February 1986

Custer National Forest



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DRAFT ENVIRONMENTAL IMPACT STATEMENT

CUSTER NATIONAL FOREST

NOXIOUS WEED TREATMENT PROGRAM

Carbon, Carter, Park, Powder River, Stillwater
and Sweetgrass Counties, Montana;

Corson, Harding, Perkins
and Ziebach Counties, South Dakota;

Billings, Golden Valley, Grant, McKenzie, Ransom, Richland, Sioux
and Slope Counties, North Dakota

Type of Action:	Administrative
Responsible Federal Agency:	Forest Service, USDA
Responsible Official:	David A. Filius, Forest Supervisor Custer National Forest P.0. Box 2556 Billings, Montana 59103
For Further Information Contact:	Susan M. Zike, EIS Team Leader Custer National Forest P.0. Box 2556 Billings, Montana 59103 Telephone: (406) 657-6361

Abstract: The draft environmental impact statement documents the analysis of six alternatives, including No Action, which were developed for the management and treatment of noxious weeds on the Custer National Forest. The net acreage of Custer National Forest is 2,445,800 acres, of which approximately 8,900 acres are infested with noxious weeds. The alternatives are: (1) No Action; (2) Total Control Program Using an Integrated Pest Management (IPM) Approach; (3) Limited Program Aimed at Large Infestation Containment; Spot Area Control Program Using Only Herbicides; (4) Integrated (IPM) Program for Containment and Control With Priority Areas Identified for Intensive Treatment; (5) Total Control Program Using Mechanical and Biological Methods Only; (6) same as Alternative 4, using only herbicide methods. Alternative 4 is the Forest Service preferred alternative. The selected alternative analyzes the environmental and human health risk for a Forestwide treatment program. The Absaroka-Beartooth Wilderness will not receive any treatment until the Regional Forester has approved a course of action specifically for it.

Comments regarding this statement should be sent to the Forest Supervisor, Custer National Forest, P.0. Box 2556, Billings, Montana 59103. Comments must be received by April 14, 1986.

ACKNOWLEDEMENTS

Significant portions of this Environmental Impact Statement were derived from:

1. The United States Department of Interior, Bureau of Land Management's (BLM) Northwest Area Noxious Weeds Control Program Final Environmental Impact Statement, December 1985; and

2. The United States Department of Justice, Drug Enforcement Administration's (DEA) Final Environmental Impact Statement of the Eradication of Cannibis on Federal lands in the Continental United States, 1985, as incorporated into the BLM's document.

The Custer National Forest did not conduct any further scientific research and the conclusions drawn in the BLM Final Environmental Impact Statement and the DEA Final Environmental Impact Statement, as appropriate to the Custer's noxious weed situation, are applied intact. Many of the scientific references in this document are taken directly from the BLM document. Specific analysis was conducted by the Custer National Forest for resource areas such as soil types and health risk analyses.

The Custer National Forest Supervisor, David A. Filius, appreciates the significant contribution provided by the Bureau of Land Management by allowing the incorporation of data and conclusions of their Final Environmental Impact Statement.

SUMMARY

The preferred alternative is Alternative 4, an integrated pest management program using herbicide, chemical, and biological methods to treat noxious weeds on the Custer National Forest. Other alternatives, including No Action as required, were considered and the analysis is documented in this Environmental Impact Statement. The Environmental Impact Statement is in compliance with the National Environmental Protection Act (NEPA) and discloses the significant environmental effects. The lands administered by the Custer National Forest are in Montana, North Dakota and South Dakota.

Several laws provide the authority for this proposal and date from the Granger-Thye Act of 1925 to the Rangeland Improvement Act of 1978. The term "noxious weed" is a legal designation and not a biological term. State laws provide for designation of certain plant species as "noxious" and require landowners to control them.

The spread of noxious weeds and the weed's competitive advantage over native vegetation threatens crop yields, rangeland productivity, wildlife habitat, and timber production. The Custer National Forest has identified species targeted for treatment. These species are:

Common Name	Scientific Name
Canada thistle	*Cirsium arvense*
Leafy spurge	*Euphorbia esula*
Russian knapweed	*Centaurea repens*
Spotted knapweed	*Centaurea maculosa*
Dalmatian toadflax	*Linaria dalmatica*
Hemp (marijuana)	*Cannabis sativa*
Sowthistle	*Sonchus arvensis*
St. Johnswort	*Hypericum perforatum*
Wormwood	*Artemisia absinthium*

Infested acres on the Custer National Forest are estimated to be 8,900. Leafy spurge, primarily in North Dakota, is estimated to be nearly 7,938 acres. Other noxious weeds, primarily the knapweeds, occuring across the Forest cannot be disregarded as the threat of spread is always present.

An integrated pest management program includes biological, mechanical and chemical (herbicides) methods. It is the herbicide applications that have caused significant public concern. The chemicals to be analyzed for use, in addition to the other available methods, on the Custer National Forest by this Environmental Impact Statement are as follows:

Herbicide	Major Trade Name
2,4-D amine	numerous
2,4-D ester	numerous
Picloram	Tordon 2K, Tordon 22K
Glyphosate	Roundup, Rodeo
Dicamba	Banvel, Banvel 10G

The decision that will result from this EIS will be whether or not to treat noxious weeds on the Custer National Forest. If it is decided to implement a treatment program, then the appropriate strategy and methods will be identified. The Red Lodge municipal watershed in the West Fork of Rock Creek (Montana) will not receive treatment until a further analysis and public involvement is made. The Regional Forester must approve any treatment in the Absaroka-Beartooth Wilderness. Therefore an environmental analysis, tiered to this Environmental Impact Statement, will be prepared for the Regional Forester's approval, when and if a treatment program is proposed.

Five issues were identified to guide this analysis. These issues tend to revolve around the economic and environmental need to treat noxious weeds and the environmental and economic effects of treating or not treating the infestations. Given the agricultural nature of the people residing within and adjacent to the Forest, there appears to be a significant concern about continuing, at least, the current Forest program in cooperation with state, county and private efforts.

Based on this and the management concerns, evaluation criteria were developed to establish a basis for comparison of the alternatives and the necessary mitigation measures (see Chapter I).

ALTERNATIVES

Six alternatives are considered in this analysis, including the Proposed Action (Alternative 4, the preferred alternative). Differences among the alternatives are primarily in the Forestwide strategy of treatment, including the intensity of treatment and the acceptable level of environmental impact of both the treatment method and the occurrence of noxious weeds in the environment.

The No Action alternative (Alternative 1), Alternative 3, and Alternative 6 are not integrated pest management programs, but are included in the analysis to expand the realm of possible alternatives and to more fully evaluate the Forest's goal of integrated pest management. All alternatives, except Alternative 1, No Action, include coordination with landowners in and adjacent to National Forest System lands.

Alternatives 2 and 4 involve an integrated pest management program including chemical, biological and mechanical. As technology further develops, the biological and mechanical methods of noxious weeds control are expected to become more and more effective and more acreage is

expected to be treated by these methods. Until that time, effective treatment tends to be chiefly herbicide to contain and control infestations.

Alternative 5 is an integrated pest management strategy, using biological and mechanical methods only. Alternative 6 contains the same strategy for treatment as Alternative 4, except that the only method considered is herbicide application.

When herbicide treatment is considered, the following chart shows the application rates that would be used.

AFFECTED ENVIRONMENT

The lands of the Custer National Forest lie within 20 counties in Montana, North Dakota and South Dakota. They are scattered from the northeast corner of Yellowstone National Park in Park County, Montana, to Richland County in the southeastern corner of North Dakota. Distances involved are about 240 miles north-to-south and 650 miles east-to-west.

LAND STATUS

National Forest Proclaimed Lands	1,186,391 acres
National Grasslands	1,260,118 acres
Non-Federal Within Boundaries	1,552,374 acres
Gross Area	3,998,756 acres
Net National Forest System Lands	**2,446,379 acres**

The Custer National Forest contains a wide variety of geologic settings, ranging from the igneous-metamorphic rocks of the Beartooth Mountains, to deep sedimentary basins, to areas of continental glaciation. Elevations range from 905 feet above sea level in the east end of the Forest to 12,799 feet above sea level in the west end of the Forest.

The climate of the Custer National Forest is continental, which means that summers are short and hot and winters are long and cold. Temperature extremes are also broadened by great elevation differences.

Moisture regimes vary from subhumid to semi-arid. Precipitation generally rises on Districts farther east from the mountains; the Sheyenne National Grasslands receives more precipitation and its ambient relative humidity is much greater than on the higher plains of eastern Montana and

APPLICATION RATES ON THE CUSTER NATIONAL FOREST

Vegetative Setting	Herbicide	Application Rate[1]
Grasslands	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A to 1 lb AI/A
	2,4-D/Picloram	1 lb AI/.125 lb AI/A to 2 lbs AI/.5 lb AI/A
	Glyphosate	1 lb AI/A
Grass/tree and Grass/shrub	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	1 lb AI/.25 lb AI/A to 2 lbs AI/.5 lb AI/A
	Glyphosate	.75 lb AI/A to 1 lb AI/A
Forest	2,4-D only	2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	2 lbs AI/.25 lb AI/A
	Glyphosate	1 lb AI/A
Riparian	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	2 lbs AI/.25 lb AI/A
	Glyphosate	1 lb AI/A
	Dicamba	1 lb AI/A

[1]Application rates can exceed these rates and still be within legal label limits. However, additional health risk analysis must be made.

western Dakotas. Mountainous areas are an exception where annual precipitation may exceed 70 inches.

There is a great variety of soils. Surface materials range from coarse glacial till and scoured bedrock in the Beartooth Mountains to finer textured silty and clayey soils in eastern Montana and the western Dakotas. Sandy glacial outwash soils occur on the Sheyenne National Grasslands in eastern North Dakota.

Currently, about 1,091,500 acre feet of water annually run off the Custer National Forest. Ninety-five percent of that water meets or exceeds minimum water quality. The badlands of North and South Dakota are an exception because the soil normally cannot be vegetated in order to reduce sediment production. Most of the other runoff water in the Forest originates in the Absaroka-Beartooth Wilderness where very little human activity occurs which could affect quantity or quality of runoff.

The population is largely rurally oriented, with strong ties to the land and to the many small towns. In both of the metropolitan counties, Yellowstone County containing Billings, Montana, and Cass County containing Fargo, North Dakota, the populations are roughly 65 percent urban and 35 percent rural.

Agriculture and its related support services are the primary economic base. The future economic situation will continue to be dependent on the stability of the agricultural base. In some counties oil, natural gas, and coal dominate the revenue picture at present, but they represent resource revenues that can fluctuate rapidly, and do not in any way negate the value of the long-term, relatively stable foundation of the renewable resources, particularly agriculture.

Economic Implications of Noxious Weeds

Spotted knapweed ranks as the number one weed problem on rangeland in Montana. It reduces livestock and big game forage, damages wildlife habitat and can double the amount of soil erosion from sites where it invades rangeland. Knapweed is estimated to cause an annual loss of forage valued at $4.5 million in Montana. Leafy spurge is considered the most persistent noxious weed in North Dakota. In North Dakota, loss of hay and beef cattle production is estimated at $7 million annually due both to reduced forage production from leafy spurge competition and to cattle avoiding leafy spurge infested areas.

ENVIRONMENTAL CONSEQUENCES

The impact on air quality from a weed treatment program would be the introduction of particulates and visible smoke from weed burning. The probability is extremely low because of the small acreage that would be burned and the remoteness of the Forest from population centers. The Forest's restriction on spraying to only low wind periods (10 mph or less) reduces the chance of airborne herbicides.

Volatilization will depend on the formulation of 2,4-D, with acids and amines being less volatile than esters, which vary from high to low. Any esters used on the Custer National Forest would be of low volatibility.

Small quantities of herbicides could ester streams through drift, but limiting spraying to wind conditions of 10 mph or less will minimize this. Some herbicides could also enter streams in surface runoff or through erosion of previously treated soils. Where streamflow results from thunderstorms, surface runoff may flush herbicide residuals into streams in detectable levels. Since some herbicides are relatively mobile, the potential exists for detectable traces to enter the ground water. The relative immobility of glyphosate prevents it from moving down into the soil profile. The degradability of picloram, dicamba, and 2,4-D highly depends on microbes in the soil and water.

No herbicides previously applied to Custer National Forest lands have been reported to reach the ground water. Although little information exists, nonfederally applied herbicides on private land have been reported to enter the ground water. In areas known to be sensitive to herbicide impacts, such as ground water recharge areas, further mitigation may be required or the proposed treatment may be dropped.

Terrestrial vegetation is the environmental component that would be most affected by the proposed weed treatment program. Treatment of noxious weeds could affect both target and nontarget vegetation. Because chemical drift can injure or kill nontarget vegetation, herbicides would not be applied by methods that would accentuate the drift problem or when weather conditions would complicate the nontarget impact.

The herbicides proposed for use, excepting glyphosate, are selective, affecting broadleaf plants but not grasses. Glyphosate is a broad spectrum, nonselective herbicide that affects most perennial plants, annual and biennial grasses, sedges,

and broadleaf plants. Some chemical residue may be left for varying periods, depending upon soil and climatic conditions.

Because chemical drift could injure or kill non-target vegetation, herbicides would not be applied when weather conditions would defeat their effectiveness or when controlling the treatment would be difficult.

Prescribed burning would suppress competing vegetation. Burning would promote regeneration of some grasses, forbs, and hardwoods but could destroy some non-sprouting shrubs and other trees.

There are no known Federally listed threatened and endangered plants on the Custer National Forest. Unidentified populations of threatened and endangered plants could be susceptible to any impacts described for terrestrial vegetation. Direct effects of injury or death to plants could immediately eliminate a species in a portion of its range. The more subtle effects of vegetation community changes could eventually eliminate a species on a specific site locally through the loss of the ability to compete with other vegetation.

If the U.S. Fish and Wildlife Service determines that any vascular plant species is threatened or endangered, a review will be made before any site-specific action to document any threatened or endangered plants known on the site and will identify measures to protect these species. If any are found, the proposed action will be modified, relocated, or abandoned as necessary to meet the requirements of the Threatened and Endangered Species Act.

Impacts to livestock could occur directly from the ingestion of toxic noxious weeds and indirectly from changes in the current forage supply and exposure to herbicides. Toxic reactions occur to livestock that ingest poisonous weeds found on the Custer National Forest (Table IV-2).

Chemical treatments are generally applied in a form or at such low rates that they do not affect livestock. Animals consuming forage treated with certain herbicides (picloram, 2,4-D, and dicamba) cannot be slaughtered for food within the period of time specified on the herbicide label. Dairy animals should not be grazed on areas treated with certain herbicides (picloram, 2,4-D, and dicamba) for the length of time specified on the label.

Impacts to birds and mammals would result primarily from the destruction of nontarget vegetation important to key habitats. Depending on the rate of application and formulation of herbicide, application would cause varying degrees of injury or losses of nontarget vegetation, thus decreasing habitat for wildlife. These losses would be insignificant in the short term because of the small areas treated and the effects of weed control would be significantly beneficial over the long term because weeds would be prevented from further degrading the habitat.

The risks to the health of wildlife and fish from exposure to the herbicides 2,4-D and glyphosate are discussed at length in the Final Environmental Impact Statement on the Eradication of Cannabis on Federal Lands in the Continental United States at pages 4-20 to 4-41 (U.S. Department of Justice, Drug Enforcement Administration, July 1985). Specifically:

> Under routine circumstances, no animals are likely to receive highly toxic or fatal doses of any of the proposed herbicides. However, under unusual circumstances, if animals are directly sprayed and feed exclusively on vegetation containing herbicide residues, individual animals could receive acute toxic herbicide doses.

Biological controls involving the use of sheep or goats would probably displace some big game species during the treatment period and might cause some temporary loss of feed for the treatment year. Other biological methods (insects, microorganisms) should not adversely affect wildlife. Biological control methods would not significantly affect aquatic plants or animals.

Mechanical and burning control measures could potentially disturb or destroy unidentified cultural resources on or near the ground surface. The potential for damage would vary with the amount of ground disturbance and burning under each alternative. Cultural resource surveys would precede management actions that could damage cultural resources. Sites discovered during these surveys will be protected in accordance with appropriate Federal regulations (36 CFR 800).

Herbicide and biocontrol methods would not create any changes in the landscape that would exceed acceptable limits. Mechanical methods would create some degree of unacceptable impacts, but usually on a short-term basis.

Wilderness character can be affected by the spread of noxious weeds and could pass unnoticed by an untrained eye until infestations were widespread. The successful competition of these plants would eventually decrease the diversity and vigor of the natural occurring vegetation. As more visitors and recreation livestock travel through the wilderness, the chances of spread increase. Forest Service policy allows chemical or hand-grubbing control for noxious weeds. Such a program would require Regional Forester approval. None of the alternatives proposes a treatment program for the Absaroka-Beartooth.

The economic and social effects of spreading noxious weeds is often difficult as the costs are often hidden and the effects tend to be cumulative. Based on current range carrying capacities estimated for livestock on the Custer National Forest (3.5 acres per animal unit month), the present acreage of noxious weeds has displaced about 2,500 AUMs. These losses are reflected in reductions of revenues to the Federal government, as well as a more local loss to the agricultural and livestock industries. The cost to the industry is estimated to be $81,120 annually.

The appropriated funded program on the Custer National Forest in 1985 was $83,000 and is not keeping up to the current rate of spread. Therefore, the losses will continue to increase annually as well as continue to threaten adjacent lands.

Human health risk is considered to be the greatest with the application of herbicides. The other methods of treatment are not considered to be threatening. Because herbicides are intended to be toxic to plants, they are designed to interfere with these vital plant processes that do not occur in animals: seed germination, hormone (auxin)-mediated growth and development, and photosynthesis. Basic biological and physiological differences between plants and animals partly account for the relatively low toxicity of herbicides to animals.

An extensive analysis of herbicides proposed for use in Region 1 has been documented in "Analysis of Human Health Risks of USDA Forest Service Use of Herbicides to Control Noxious Weeds in the Northern Region". This document provides the basis to analyze the human risk associated with the noxious weeds program on lands administered by the Custer National Forest.

The herbicides considered for use on the Custer National Forest are glyphosate, 2,4-D, picloram, and dicamba. None of the application rates exceed the tolerable limits for exposure. All of the chemical are considered to be carcinogenic and the risk of cancer, especially for the workers, is disclosed in Appendix B. The worker is considered to be the vulnerable top complications from herbicide exposure. The rate and method of application are the factors that add to the vulnerability. The chemicals proposed for use on the Custer National Forest have not been found to cause significant mutagenic or carcinogenic effects.

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CHAPTER I
PURPOSE OF AND NEED FOR ACTION

This Environmental Impact Statement (EIS) in compliance with the National Environmental Protection Act (NEPA) documents the analysis and discloses the significant environmental effects of a preferred alternative and other alternatives for noxious weed control on lands administered by the Custer National Forest in Montana, North Dakota and South Dakota.

The following laws provide authority for control of noxious weeds on National Forest System Lands:

a. The Granger-Thye Act of 1925, Section 12(40), provides for "eradication of poisonous plants and noxious weeds, in order to protect or improve the future productivity of the range." 36 CFR 222.8 states that the "Chief, Forest Service, will cooperate with county or other local weed control districts in analyzing noxious farm weeds problems and developing control programs in areas of which the National Forest and National Grasslands are a part." (See FSM 2253.)

b. Carlson-Foley Act (Public Law 95-583) of October 17, 1968, authorizes and directs heads of Federal departments and agencies to permit control of noxious plants on Federal land by state and local governments on a reimbursement basis in connection with similar and acceptable weed control programs being carried out on adjacent non-Federal land. This Act carries the provision "That such reimbursement shall be only to the extent that funds appropriated specifically to carry out the purposes of this Act are available, therefore, during the fiscal year in which the expenses are incurred."

c. Section 9 of the Federal Noxious Weed Act of 1974 provides for the control and eradication of noxious weeds and the regulation of movement in interstate or foreign commerce of noxious weed and potential carriers thereof. It authorizes the Secretary to "cooperate with other Federal agencies, state agencies, or political subdivisions thereof, and individuals in carrying out measures to eradicate, suppress, control or prevent the spread of any noxious weed."

d. The Federal Land Policy and Management Act of October 21, 1976 (Public Law 94-579), establishes authority to control weeds on rangeland as a part of a range improvement program.

e. The National Forest Management Act of 1976 provides authority for removal of deleterious plant growth and undergrowth and provides for expenditure of funds to serve as a catalyst to encourage better management of private forests and rangelands.

f. Rangeland Improvement Act of 1978 (Public Law 95-514) provides for management, maintenance, and improvement of public lands suitable for livestock grazing so that they become as productive as feasible.

The term "noxious weed" is a legal designation and not a biological term. State law provides for designation of certain plant species as "noxious" and requires landowners to control them. The states of Montana, North Dakota and South Dakota have established a list of plant species considered noxious in their states and have passed noxious weed control legislation. See Appendix A, State Listed Noxious Weeds. Counties may declare certain weeds noxious in addition to the state lists. The Custer National Forest's intent in noxious weed treatment is to cooperate with local, state and Federal agencies and private landowners.

Spread of noxious weeds and the weed's competitive advantage over native vegetation threatens crop yields, rangeland productivity, wildlife habitat, and timber production. Table I-1 identifies the target species on the Custer National Forest and displays the annual average spread and impact from noxious weeds on rangeland productivity. The current and projected impact of noxious weeds such as spotted knapweed and leafy spurge have been extensively studied and documented.

Spotted knapweed

Spotted knapweed ranks as the number one weed problem on rangeland in Montana, and losses are estimated to reach a value of $4.5 million (French and Lacey 1983). Leafy spurge is considered the most persistent noxious weed in North Dakota. It has a wide habitat suitability, prolific reproduction capabilities, strong competitive ability, and is difficult to control. In North Dakota, loss of hay and beef cattle production is estimated at $7 million annually due both to reduced forage production from leafy spurge competition and to cattle avoiding leafy spurge infested areas (Lym and Messersmith 1983). See Chapter IV, Environmental Consequences, for further discussion of economic impacts of noxious weed infestations.

Other weeds listed in Table I-1 produce somewhat similar effects on rangeland as the two species listed above. The economic impacts of these weeds are a direct correlation between loss of carrying capacity and acres infested.

TABLE I-1

NOXIOUS WEED TARGET SPECIES TO BE TREATED

Common Name	Scientific Name	Origin	Life Duration	Average Annual % of Spread[1]	Average Annual Reduction of Carrying Capacity[1]	Reported Toxic Effects to Other Plants
Canada thistle	*Cirsium arvense*	Eurasia	Creeping perennial	10	42	no
Leafy spurge	*Euphorbia esula*	Eurasia	Creeping perennial	12	59[2]	no
Russian knapweed	*Centaurea repens*	Eurasia	Creeping perennial	8	55	yes
Spotted knapweed	*Centaurea maculosa*	Eurasia	Biennial or simple perennial	24	80	yes
Dalmation toadflax	*Linaria dalmatica*	Europe	Creeping perennial	8	46	no
Hemp (marijuana)	*Cannabis sativa*	Eurasia	Annual	12	—	—
Sowthistle	*Sonchus arvensis*	Eurasia	Creeping perennial	—	—	—
St. Johnswort	*Hypericum perforatum*	Eurasia	Creeping perennial	—	—	—
Wormwood	*Artemisia absinthium*	Eurasia	Perennial	5	40	no

[1]Averages obtained from personal communications with the following weed scientists:
Dr. Pete Faye, Montana State University, Bozeman, Montana
Dr. Calvin Messersmith, North Dakota State University, Fargo, North Dakota
Dr. Rodney G. Lym, North Dakota State University, Fargo, North Dakota
Dr. John R. Lacey, Montana State University, Bozeman, Montana
Celestine Lacey, Montana State Weed Coordinator, Helena, Montana

[2]Utilization by cattle and horses is zero.

Tables I-2 and I-3 show the distribution of noxious weed infestations across the Custer National Forest.

TABLE I-2

ACRES OF NOXIOUS WEEDS ON THE CUSTER NATIONAL FOREST (BY STATE)

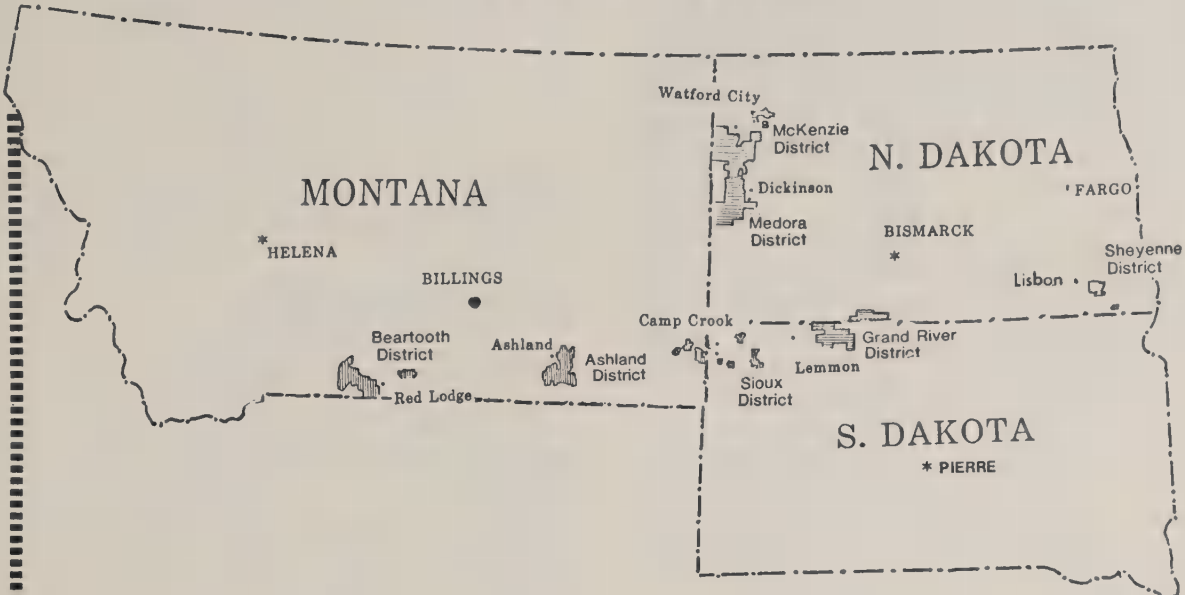
Species	Montana	North Dakota	South Dakota	Total
Leafy spurge	123	7,938	62	8,123
Spotted knapweed	598	5	10	613
Canada thistle	27	40	3	70
Hemp	0	40	0	40
Russian knapweed	21	0	8	29
Dalmation toadflax	12	0	0	12
Wormwood	0	10	0	10
Sowthistle	0	2	0	2
St. Johnswort	1	0	0	1
TOTAL	782	8,035	83	8,900

TABLE I-3

ACRES OF NOXIOUS WEEDS ON THE CUSTER NATIONAL FOREST (BY RANGER DISTRICT)

Species	Sheyenne RD	Beartooth RD	Sioux RD	Ashland RD	Grand RD	Medora RD	McKenzie RD
Leafy spurge	5,163	3	150	0	32	2,500	175
Spotted knapweed	0	114	40	454	0	5	0
Canada thistle	5	6	10	14	0	5	30
Hemp	40	0	0	0	0	0	0
Russian knapweed	0	0	0	21	8	0	0
Dalmation toadflax	0	12	0	0	0	0	0
Wormwood	10	0	0	0	0	0	0
Sowthistle	2	0	0	0	0	0	0
St. Johnswort	0	0	0	1	0	0	0
TOTAL	5,220	135	200	490	40	2,510	205

VICINITY MAP



LAND STATUS

National Forest Proclaimed Lands	1,186,391 acres
National Grasslands	1,260,118 acres
Non-Federal Within Boundaries	1,552,374 acres
Gross Area	3,998,756 acres
Net National Forest System Lands	**2,446,379 acres**

Sheyenne Ranger District (National Grasslands)	70,180 acres
Grand River Ranger District (National Grasslands)	161,886 acres
Sioux Ranger District (National Forest)	162,897 acres
Medora Ranger District (National Grasslands)	524,765 acres
McKenzie Ranger District (National Grasslands)	503,157 acres
Ashland Ranger District (National Forest)	436,007 acres
Beartooth Ranger District (National Forest	587,487 acres
	2,446,379 acres

The chemicals to be analyzed for use on the Custer National Forest by this Environmental Impact Statement are as follows:

Herbicide	Major Trade Name
1. 2,4-D amine	numerous
2,4-D ester	numerous
2. Picloram	Tordon 2K, Tordon 22K
3. Glyphosate	Roundup, Rodeo
4. Dicamba	Banvel, Banvel 10G

DECISIONS TO BE MADE

The decision that will result from this EIS will be whether or not to treat noxious weeds on the Custer National Forest. If it is decided to implement a treatment program, then the species to be treated and the appropriate methods will be identified.

Of particular public interest are the regulations that apply to treating noxious weeds in the Absaroka-Beartooth Wilderness on the Beartooth Ranger District of the Custer National Forest. Per Forest Service Manual (FSM) 2323.04c, "Unless specifically reserved to the President (FSM 2323.04a) or the Chief (FSM 2323.04b), or assigned to the Forest Supervisor (FSM 2323.04d), the Regional Forester will approve all measures implementing direction on the use of

resources in FSM 2323 through 2323.9." These sections list resources and related activities such as visitor use and distribution, wildlife habitat, and grazing activities. FSM 2323.24b directs "Plant control shall be approved only for noxious farm weeds by grubbing or with chemicals when they threaten lands outside wilderness or are spreading within the wilderness, provided control can be affected without serious adverse impacts on wilderness values." This Environmental Impact Statement will disclose the environmental consequences of noxious weed treatment for the entire Custer National Forest, including the wilderness. However, recognizing that the Regional Forester must approve all measures in the Wilderness and this EIS is under the authority of the Forest Supervisor, an environmental analysis will be prepared for the Regional Forester's approval on a site-specific basis, when and if a treatment program is proposed for the Absaroka-Beartooth Wilderness. That analysis will be tiered to this Environmental Impact Statement.

ISSUES, CONCERNS AND OPPORTUNITIES

Through a public scoping effort which included an information mailing to nearly 2,200 interested parties and numerous personal contacts with legislative, researchers, and regulatory personnel, the following issues were identified:

1. Noxious weeds must be treated to prevent loss of grazing capacity and to stop further spreading to uninfested lands.

2. Herbicide application must be made in a prudent and proper manner, in respect to the potential health risk.

3. Treatment must be in such a way as to not impact vegetative sensitive species and habitats.

4. Herbicide application must take into account the detrimental effects on livestock and wildlife.

5. The Forest must continue to be "Good Neighbors" by cooperating with state laws, county regulations, and Forest users.

The Custer National Forest has been implementing a noxious weed program for the past several years and the following management concerns represent the items that are known to be of interest:

1. In light of fiscal austerity, the cost of a total control program may be prohibitive.

2. Range conditions and vegetative diversity may significantly suffer over time by the successful competition of noxious weeds against desirable plants and the non-utilization of noxious weeds by most livestock. Conversely, because of nontarget species susceptibility to herbicide, some diversity may be lost in the short term.

3. Research has suggested that label recommended rates of herbicide application appear to be excessive for some treatment needs. Use of label recommended rates can result in greater cost and greater opportunity for nontarget species mortality.

4. Grazing management systems must be designed to maintain ranges in good or better condition in cooperation with a weed treatment program.

OPPORTUNITIES

Many questions remain on the optimum strategy for controlling certain noxious weeds, especially leafy spurge (*Euphorbia escula*), and the knapweeds (*Centurea repens* and *C. maculosa*).

Because of the extent of the noxious weed infestations on the Custer National Forest and the public and academic concern for effective control, there is an excellent opportunity for research on the Forest. There are already on-going research projects with Rocky Mountain Experiment Station and North Dakota State University, particularly in the Sheyenne Ranger District.

The following research needs have been identified; they will be evaluated by the Regional Forester for inclusion in the Regional research program proposal as a part of the Custer Forest Plan. It is anticipated that more research needs will become apparent during monitoring and evaluation of the Forest Plan as it is implemented.

1. How effective are non-chemical control methods such as grazing sheep, mowing noxious weed infestations, releasing insects or pathogens for biological control, and prescribing burns?

2. What is the viability of certain weed species seed?

3. What is the extent of cumulative or long-term effects of chemical applications especially on nontarget species?

4. What are the most effective chemicals, application rates, and timing strategies to control target species?

5. What role does the taxonomy and phenology of noxious weed species play in effective control?

EVALUATION CRITERIA

Evaluation criteria are developed to establish a basis for comparison of the alternatives. These criteria are based on the scope of the analysis, the objective of the analysis, and the public issues and management concerns. There are some criteria that are common to all alternatives. These are:

1. All alternatives will meet state water quality requirements.

2. All alternatives will be within the laws and regulations governing the USDA Forest Service.

3. Key wildlife species are identified for the purpose of this analysis to be the species of major interest: elk, mule deer, white-tailed deer, big horn sheep, sharptail grouse, prairie chicken, cutthroat trout and large-mouthed bass. These habitats will be maintained in all alternatives, but not necessarily unaffected.

4. All alternatives will be responsive to the areas containing unique plants and all activities will be managed to retain the habitat for these species. Unique vegetation known to occur on the Custer National Forest can be found in Appendix H.

5. All herbicides considered for use will be EPA (Environmental Protection Agency) approved and will be applied within the label restrictions (see Appendix J).

In addition to these criteria, there are mitigation measures that are also common to all of the alternatives. These can be found in Chapter II, Alternatives, Including the Proposed Action.

The following evaluation criteria is used to evaluate the alternatives and will indicate significant differences among the alternatives.

1. The proposed action should meet the Forest's noxious weed goal to implement a cost-effective integrated pest management program aimed at controlling new starts, priority areas (defined in Glossary) and minor infestations. Holding actions would be implemented on existing large infestations.

2. The proposed action should meet the intent of the Forest's range management objective of improving overall vegetative condition.

3. The proposed action should not significantly adversely affect identified key wildlife and fisheries species habitats.

4. The proposed action should be within the identified limits of human health risk (see Appendix B).

5. The proposed action should not significantly adversely affect nontarget vegetation (forbs, shrubs, and trees).

6. The proposed action should effectively limit the spread of noxious weeds on Federal lands and prevent spreading to adjacent lands.

The analysis of the alternatives against these criteria can be found in Chapter II, Alternatives, Including the Proposed Action.

CHAPTER II ALTERNATIVES

INCLUDING THE PROPOSED ACTION

This chapter is divided into a number of sections and is the heart of the Environmental Impact Statement. The sections are as follows:

- Description of the Alternatives
- Identification of Alternatives Considered But Not Carrried Forward
- Treatment Methods
- Ecology of Noxious Weeds Found on the Custer National Forest
- Mitigation Measures Common to All Alternatives
- Evaluation of Alternatives
- Alternative Comparison Chart
- Identification of Preferred Alternative

DESCRIPTION OF THE ALTERNATIVES

This chapter presents the environmental impacts of the alternatives in comparative form and provides a basis for choice among the options. Six alternatives have been considered in this analysis, including the proposed Action (Alternative 4, the preferred alternative). Differences among the alternatives are primarily in the Forestwide strategy of treatment, including the intensity of treatment and the acceptable level of environmental impact of both the treatment method and the occurrence of noxious weeds in the environment.

While these alternatives are Forestwide in scope, there are some areas of special concern that will require further public scoping and an environmental analysis tiered to this Environmental Impact Statement (EIS). These areas are, but not limited to, the Absaroka-Beartooth Wilderness, Red Lodge (Montana) Municipal Watershed (the West Fork of Rock Creek) and locations of unique plant species. The environmental consequences of treatment methods are disclosed in this EIS, but the specific mitigation measures for these areas of special interest will be defined at the time of project proposals.

The integrated pest management (IPM) approach is a comprehensive systems approach to achieving economical pest control in an environmentally acceptable manner. The individual components of integrated pest management include: mechanical (including cultural, manual, and prescribed fire techniques), biological, and chemical. Each of the components may be used alone or enhanced by combining and timing with other methods to produce a more effective pest management strategy.

The No Action alternative (Alternative 1), Alternative 3, and Alternative 6 are not integrated pest management programs but were included in the analysis to expand the realm of possible alternatives and to more fully evaluate the Forest's goal of integrated pest management. All alternatives, except Alternative 1, No Action, include coordination with landowners in and adjacent to National Forest System lands.

Alternatives 2 and 4 involve an integrated pest management program including chemical, biological and mechanical. As technology further develops, the biological and mechanical methods of noxious weeds control is expected to become more and more effective and more acreage is expected to be treated by these methods. Until that time, effective treatment tends to be chiefly herbicide to contain and control infestations.

Alternative 5 is an IPM strategy, using biological and mechanical methods only. Alternative 6 contains the same strategy for treatment as Alternative 4, except that the only method considered is herbicide application.

Alternative 1 — No Action. This is the No Action Alternative required by CEQ (Council of Environmental Quality) regulation 1500-1508. Under this alternative, no attempt would be made to control or contain the spread of noxious weeds within the Forest or coming onto or leaving National Forest System lands.

Alternative 2 — This is an IPM program directed at all known noxious weed infestations. This alternative would allow treatment of all noxious weed infestations within current laws and regulations. This alternative would emphasize eradication of noxious weed infestations not withstanding size. Estimated acres treated under this alternative would be 8,900.

Alternative 3 — This herbicide-only treatment is directed toward (1) containment of large infestations, and (2) control spot and new infestations. Implementation of this alternative would provide a "holding action" against the large (greater than 10 acres) noxious weed infestations and "control action" on the spot and new infestations (less than 10 acres). Estimated acres treated under this alternative would be 5,280.

Alternative 4 — Strategies of this IPM alternative are similar to Alternative 3, but adds additional treatment action on selected areas. Guidelines for selecting a priority for treatment may include, but are not limited to, (1) possibility of spreading noxious weeds by Forest users, animals, water, or wind; (2) possibility of improving effectiveness by coordinating with other adjacent control efforts; (3) possibility of improving effectiveness by tak-

ing advantage of climatic and seasonal conditions. This alternative would attempt to "get ahead" of the noxious weed invasion on the Forest. Estimated acres to be treated under this alternative could amount to 8,900, depending on the success of the control in the priority areas.

Alternative 5 — This integrated pest management program is directed at treating noxious weeds by known mechanical and biological controls, without the application of any herbicide. It is assumed that only existing large infestations would provide the adequate environment to apply these methods. Recognizing the limited short-term effectiveness of these methods, this alternative would be an attempt to only limit the advance of noxious weeds while not exposing the environment and humans to the chemical risks. Estimated acres treated under this alternative would be 5,800.

Alternative 6 — This herbicide-only program is essentially the same as Alternative 4, except that herbicide application would be the only treatment considered. The parameters of treatment would be the same as Alternative 4, but no mechancial or biological would be considered. Estimated acres treated under this alternative would be 8,900.

Table II-1 summarizes the acres to be treated.

TABLE II-1

ACRES TO BE TREATED OVER TIME BY ALTERNATIVE

Alternative	Acres
1	0
2	8,900
3	4,730
4	8,900[1]
5	5,800
6	8,900

[1]See alternative description

ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD

A total herbicide strategy was considered for Alternative 2. However, upon closer analysis, the required widespread, reoccurring herbicide application presented too great a chance for human health risk.

An IPM program was considered for Alternative 3 but was determined to be unfeasible, particularly with biological control agents that would treat more than the edges of large infestations. Additionally, biological control agents tend not to be effective in small or spot infestations.

TREATMENT METHODS

Chemical Control

Application of herbicides varies with specific objectives and target species. The herbicides considered for use in this analysis are:

Herbicide*	Active Ingredient
Tordon 2K	Picloram
Tordon 22K	Picloram
Rodeo, Roundup	Glyphosate
2,4-D	2,4-D ester, amine
Banvel, Banvel 10G	Dicamba

*Trade names are used only for identification and do not indicate produce endorsement.

The effectiveness of various herbicides is due to the pathways which the herbicides enter the plant. It can be through direct contact with the above-ground structure, or indirect uptake through the root system. Treatment may also be specific for post-emergence of the targeted species. Herbicides are also categorized as selective for a particular type of plants or nonselective which means many types of plants would be impacted. Generally, the proposed herbicides are intended to be applied directly to the plant leaves.

TABLE II-2

PROPERTIES OF VARIOUS HERBICIDES

Herbicide	Formulation	Target Plants	Effective Treatment Period	Persistence In Soil
2,4-D	Liquid	Selective-broadleaf	Post-emergence	1 month
Dicamba	Liquid Granular	Selective-broadleaf	Pre-emergence Post-emergence	3-12 months
Glyphosate	Liquid	Nonselective	Post-emergence	1 month
Picloram	Liquid Granular	Selective (Some applications and formulations cover a wide spectrum)	Pre-emergence Post-emergence	1+ year

The most effective treatment period is directly correlated to specific plant growth periods, being optimal during rapid growth periods and maximum translocation.

Further information on the properties of each herbicide can be found in Table II-2, or in "Pesticides Background Statement: Volume 1, Herbicides" (USDA, FS 1984).

Application rates are measured in pounds of active ingredient (AI) per acre. The rates can vary for each herbicide depending on the objective and method of treatment. Various combinations of herbicides may also be utilized and AI/ac modified. Application rates on the Custer National Forest are often less than the maximum allowed through the State/EPA label restrictions, Table II-3. The application rates for the Custer National Forest are shown in Table II-4.

TABLE II-3
MAXIMUM APPLICATION RATES ALLOWED BY STATE/EPA

Herbicide	Trade Name[1]	Application Rate
2,4-D amine salt or butyl ester	Numerous	4 lbs AI/ac
Dicamba	Banvel liquid	4 lbs AI/ac
	Banvel 10G	8 lbs AI/ac
Glyphosate	Rodeo, Roundup	4 lb AI/ac
Picloram	Tordon	2 lb AI/ac

*Trade names are used only to provide information and do not imply product endorsement.

TABLE II-4
APPLICATION RATES ON THE CUSTER NATIONAL FOREST

Vegetative Setting	Herbicide	Application Rate[1]
Grasslands	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A to 1 lb AI/A
	2,4-D/Picloram	1 lb AI/.125 lb AI/A to 2 lbs AI/.5 lb AI/A
	Glyphosate	1 lb AI/A
Grass/tree and Grass/shrub	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	1 lb AI/.25 lb AI/A to 2 lbs AI/.5 lb AI/A
	Glyphosate	.75 lb AI/A to 1 lb AI/A
Forest	2,4-D only	2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	2 lbs AI/.25 lb AI/A
	Glyphosate	1 lb AI/A
Riparian	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	2 lbs AI/.25 lb AI/A
	Glyphosate	1 lb AI/A
	Dicamba	1 lb AI/A

[1]Application rates can exceed these rates and still be within legal label limits. However, additional health risk analysis must be made.

A variety of application methods are available for use. The method of selection would be based on objectives, manpower, topographic limitations, economics, equipment availability, and potential impacts.

Herbicides are available in liquid and granular formulations. Liquid formulations would use water as the carrier and may be enhanced by the use of surfactants. Application of liquid formulations would be limited to wind velocities 10 mph or less and air temperatures 80 degrees F or below. In addition, all guidelines and label restrictions will be followed to assure proper application. Many herbicides have restrictions near surface water and areas with high water tables.

Vehicle-mounted spray equipment with a boom, single floodjet and hand-held pressure nozzles (less than 30 psi) would be used most often on open range projects when accessible. The boom sprayer or single floodjet would be used in areas with large contiguous stands of the target species.

Backpack spray, hand-held pressure nozzles, or hand-held CDA's applications would be utilized where terrain, cost effectiveness, or environmental concerns would limit other methods. These would allow very specific, individual plant treatment.

Control droplet applicators (CDA's) would be used in a variety of settings. The most common use of CDA's is singularly-mounted heads and multiple-head booms on vehicles or hand-held units. CDA's allow the herbicide to be applied in microdroplet form, allowing a lower volume of the carrier and herbicide to be used. This may increase the potential for plant intake.

Granular application would be made with shakers or broadcast spreaders. This is a labor intensive method which is usually limited to small areas of infestations.

Other application methods such as aerial applications would not be utilized unless they met the intent of the Forest's noxious weed program and would be within the bounds of the human risk analysis and management constraints. Currently, there are no immediate plans for this type of application.

Mechanical Methods

Noxious weeds can be treated by various mechanical methods such as prescribed burning, mowing, tilling, and livestock (sheep) grazing. Burning can be implemented when weather or fuel conditions are favorable, usually between March and November and only at times approved by state organizations responsible for smoke management. Burning permits will be obtained where required.

All burning would be conducted in accordance with Custer National Forest fire management policy which requires the preparation of a prescribed burning plan before every burn. The prescribed burning plan addresses the following: physical characteristics of the burn area, objectives of the burn, fuels on site (loading and characteristics), weather conditions under which the plan will be carried out, expected fire behavior, air and water quality restrictions, ignition pattern and sequence, emergency fire control force requirements, public contacts, and safety.

The most common methods are hand-held fusees and drip torches and are applied directly to the vegetation. When using either hand-carried drip torches or fusees, individuals cross the area in a specified pattern described in the prescribed burning plan. Tailoring traverse patterns to each area identified to be treated can maintain effectiveness, maximum safety, and control.

Mowing and tilling (such as discing or plowing) prevent plants from producing seeds when treated in the bud stage or earlier. Efforts repeated every 21 days during the growing season can deplete the underground food supply of some perennials. These methods would be required for at least a 3-year period to attain satisfactory control. Tilling would be considered only in areas where slope is less than 10 percent and a small percentage of the vegetation consists of shrubs. Mowing is acceptable on slopes greater than 10% and the density of shrubs in areas treated would be dependent upon local wildlife need. These methods would also weaken non-target species in treated areas.

Biological Control

Biological control indicates various methods to re-create a natural balance of plant species and natural predators. Because many of the plants identified as "noxious" are not native to North America and natural predators do not occur, biocontrol efforts try to mimic the original setting. Biocontrol includes insects, animals, or pathogens (fungus).

Clearances are required for the release of any biocontrol agent in the states of Montana, North Dakota and South Dakota. There are two Federal clearing laboratories, Beltsville, Maryland, and Albany, California. Additionally, a Working Group, consisting of representatives of various Federal agencies and others, provides testing to further clear biocontrol agents. The states of North Dakota and Montana require an additional review of evidence and a state permit before an agent is released. South Dakota requires only the Federal clearances before a release is made.

There is very little data available from which to evaluate the efficacy of biological control agents

(Nowierski 1985). The nature of biological control programs does not easily lend itself to evaluation at this point in time. Research in this area has only recently indicated encouraging results. Conclusions are yet difficult to make. Three primary considerations in analyzing biocontrol were identified and discussed below:

1. availability of biocontrol agents,
2. cost per treated acre, and
3. effectiveness.

Availability of Biocontrol Agents

Although extensive research is being conducted by several USDA and university laboratories, there are few organisms available for the control of the noxious weeds found on the Custer National Forest. Three weed species are susceptible to currently implementable control measures. These are diffuse knapweed (*Centaurea diffusa*), spotted knapweed (*Centaurea maculosa*), and leafy spurge (*Euphorbia esula*). A fourth noxious weed, Canada thistle (*Cirsium arvense*), is marginally susceptible. It is an alternate host to *Rhinocyllus conicus* which is very effective on musk thistle (*Carduus nutans*) (Nowierski 1985). Musk thistle does not occur on the Custer National Forest. The rhinocyllus weevil does not control Canada thistle very effectively and is eliminated from consideration.

Cost Per Acre

No cost-per-acre estimates are currently available (Nowierski 1985). The primary cost encountered in knapweed control is associated with the transportation to established gall fly colonies, the collection of flower heads, and the distribution of these seed heads on infested land.

The hawkmoth (for use against leafy spurge) is less available than the gall fly. It was distributed to 42 sites in 1985 (Nowierski 1985). Efforts in 1985 to establish viable populations in Montana have been concentrated on five sites (Nowierski 1985), none on the Custer National Forest.

Effectiveness

Biocontrol strategies are not easily assessed in terms of effectiveness. There is no data available on the effectiveness of these agents in the Northern Region of Forest Service, which includes the Custer National Forest (Nowierski 1985). Successful biological control strategies generally work by multiple-stressing target species, i.e., weakening the plants by one method, then employing another method to eradicate them. It is difficult to accurately analyze the effectiveness of a particular agent in a biological control program because such programs are often based on the combined efforts of several species.

Research has shown that to date none of these agents reduce plant density by themselves in the short term (less than 20 years). Knapweed gall flies are used to reduce the spread of seed. Canadian researchers report that aside from the immediate decline in seed production and biomass which can be counter-balanced by seeds in soil under dense stands of knapweed, studies indicate that the flies should eventually achieve a large decline in knapweed density.

The biological control of spurge in Canada has so far been a failure. Most of the European insect species tested have failed to control North American leafy spurge. North American leafy spurge is thought to be a hybrid and differs in its susceptibility to agents which are destructive to European spurges. Tests using the leafy spurge hawkmoth have, however, been encouraging. It is believed that the establishment of any insect in reasonable numbers should be regarded as a success as it contributes to the cropping pressure on the weed in North America. Additonally, research is showing promise of combining herbicide and biocontrol methods. While encouraged by the newest research results, the Custer National Forest cannot justify a pest management program entirely based upon biocontrol strategies. Research has not yet concluded minimum acreages needed to support a biological agent population. It is theorized that spot infestations are inadequate, thus rendering this method ineffective on small projects. The minimum acreage is expected to vary by agent.

Conclusions

The sole use of biological control measures does not appear to enable a treatment program to achieve the Forest's goal of noxious weed treatment. More data regarding effectiveness and treatment costs will help in proper evaluation of this option and the ability to incorporate it into an integrated pest management program. As effective agents become available, they may be used to augment primary treatment schemes.

ECOLOGY OF NOXIOUS WEEDS FOUND ON THE CUSTER NATIONAL FOREST

This discussion identifies the weeds targeted for treatment. Properties of taxonomy and phenology of the plants are discussed that may have implications for the method or effectiveness of treatment.

Canada Thistle (*Cirsium arvense*)[1]

Canada thistle, a member of the sunflower family, is a perennial forb that reproduces by horizontal roots and seed. The hollow stems are about 4 feet high and branch near the top. The wavy leaves are oblong to lance-shaped and can be very irregular and deeply cut with spiny to smooth (with no

spines) margins. The flower heads are numerous, small, compact and vary from light lavender to rose-purple.

Canada thistle grows in cultivated fields, meadows, pastures and waste places. It occurs in all three states in the Custer National Forest, Montana, North Dakota, and South Dakota.

Herbicide treatment should occur when the plant is actively growing and approximately 12 inches tall in the spring of the year. Fall treatment can be achieved if mowed and allowed to regrow.

Leafy Spurge (*Euphorbia esula*)[1]

Leafy spurge is a member of the spurge family and is known to have developed several subspecies. It is a perennial forb that reproduces by vigorous rootstalks and seeds. The weed forms dense patches, and stems vary from 1 to 3 feet in height. The small flowers are enclosed by a pair of yellowish-green, heart-shaped bracts. The bracts have the appearance of flowers. Stems, leaves and flowers contain a milky sap called latex.

Leafy spurge is most common in fields and pastures. Although this weed may first become established in moist places, it is also well adapted to dry, upland sites and shallow, rocky soils. It occurs on the Custer National Forest in Montana, North Dakota, and South Dakota.

Leafy spurge may well be the most persistent noxious weed on the Custer National Forest. It has a wide habitat suitability, prolific reproduction capabilities, strong competitive ability and is difficult to control. Once established, it significantly decreases production of other vegetation on the site. Although it is unpalatable to cattle, sheep eat the weed and do well on it.

Herbicide treatment should occur when the plant is actively growing and in the early bud stage. Treatment may occur in the spring or fall. Research is exploring various biocontrol agents.

Dalmation Toadflax (*Linaria dalmatica*)[1]

Dalmation toadflax is a member of the snapdragon family. It is a perennial forb that spreads by creeping roots and seed. The plants are usually about 2 feet tall, pale green and have very showy, yellow flowers. The "spurred" flowers are tinged with orange and are about 1 inch long. The leaves are broad, heart-shaped and clasp the stem.

Dalmation toadflax is an escaped ornamental that invades rangeland, mountain meadows and waste areas. It is known to occur on the Custer National Forest in Montana only.

Herbicide treatment should occur when the plant is in the early bud or rosette stage with picloram, and the early bloom stage with 2,4-D.

Goatweed (*Hypericum perforatum*)[1]

Goatweed or St. Johnswort is a perennial forb in the St. Johnswort family. It reproduces by seed and rootstock. Stems are smooth, branched, about 3 feet tall and woody at the base. The opposite leaves are elliptic to oblong and have small, glandular dots. The orange-yellow flowers are about 3/4 inch in diameter and five-petaled. The three-parted seed pods are round, pointed and contain many seeds.

Goatweed is found in meadows, dry pastures, neglected fields and roadsides and is known to occur only on the Montana portion of the Custer National Forest. It is difficult to eradicate. Grazing animals do not eat the plant unless forced. Goatweed causes photosensitization in livestock and should be regarded as a poisonous plant.

Herbicide treatment should occur in the early bud stage and when actively growing.

Russian Knapweed (*Centaurea repens*)[1]

Russian knapweed is a member of the sunflower family. It is a perennial forb that spreads by creeping rootstocks and seed. Plants vary from 1 to 3 feet in height and have numerous branches that are tipped with a single, lavender, thistle-like flower. The upper leaves are small and narrow with broken edges. Leaves attached midway up the stem have slightly toothed margins, while basal leaves are deeply notched. Short, stiff hairs cover the leaves and stems. The roots are dark brown and have a scaly appearance.

Russian knapweed is found on both irrigated and dryland pasture, range and hayland. Once established, it will completely crowd out other vegetation. Livestock tend to avoid the weed because of its bitter, quinine-like taste. However, if horses are forced to graze Russian knapweed, they will develop nervous disorders. It is known to occur on the Montana and South Dakota portions of the Custer National Forest.

Herbicide treatment with picloram could occur any time during the growing season, and with 2,4-D-picloram.in the bud to bloom stage.

Spotted Knapweed (*Centaurea maculosa*)[1]

Spotted knapweed, a member of the sunflower family, is a biennial or short-lived perennial forb that reproduces by seed. Seeds germinate in the fall or spring, whenever growing conditions are favorable. Plants usually remain in the rosette stage during the first year. Stems grow to a height of 1 to 3 feet. The showy, purple flowers are held in spotted bracts. The alternate leaves have deep, narrow divisions and a rough, hairy appearance.

Spotted knapweed leaves contain a chemical compound that could suppress the germination and growth of other plants if released into the soil.[4]

Spotted knapweed is found in every county in Montana and is spreading into North Dakota and South Dakota. It readily establishes on any disturbed site and thrives under a wide range of environmental conditions. Once established, it will completely crowd out other vegetation.

Herbicide treatment could occur in the bud to bloom or rosette stage.

Hemp Family (*Cannabis sativa*)[2]

Hemp is an annual that may grow to a height of 16 feet. Male and female flowers occur on separate plants. Male flowers are green with no petals but have five sepals. The male plants die soon after shedding pollen. The female plant produces petalless flowers in the axils of the upper leaves. Plants flower in July to September and produce seed from August to frost. Leaves are opposite or alternate, petioled and palmately compound with 5 to 11 leaflets.

Hemp is found on low rich bottom land along streams but can be found in waste areas, around farm buildings, pastures, road ditches and fence rows. The drug marijuana is made from parts of the hemp plant. It is only known to occur in the North Dakota portion of the Custer National Forest.

Herbicide treatment could occur in the early spring when the plant is actively growing and less than 6 inches tall.

Wormwood (*Artemisia absinthim*)[3]

Wormwood is a perennial reproducing by seed. It grows to a height of two to four feet and has many branched stems. Leaves are two to five inches long attached to the stem with long petioles. The numerous flowers are yellow, drooping and short stalked.

Wormwood is found primarily in pasture, but also in hay meadows, roadsides and waste places. It is an escaped ornamental and occurs on the Custer National Forest only in North Dakota.

Herbicide treatment could occur while the plant is actively growing and less than 12 inches tall.

Perennial Sowthistle (*Sonchus arvensis*)[5]

Perennial sowthistle is a member of the Composite family and is a perennial reproducing by seed and creeping rhizomes. The roots are deep penetrating, widely spreading horizontally and producing new shoots from frequent buds on fleshy rhizomes. The erect stems are smooth or glandular, hairy, leafy, hollow and branched at the top. The numerous flower heads are on the end of terminal branches. They are a deep yellow and 1 to 1½ inches in diameter. The flower bracts are dark green or lead colored. This plant is known only to occur in the North Dakota portion of the Custer National Forest.

Herbicide treatment should occur when the plant is actively growing and approximately 12 inches tall in the spring of the year. Fall treatment can be achieved if mowed and allowed to regrow.

[1]Controlling Pasture and Range Weeds in Montana, Cooperative Extension Service, Montana State University, Bozeman, Montana, February 1985, Bulletin 362.

[2]Nebraska Weeds, State of Nebraska, Nebraska Department of Agriculture, Lincoln, Nebraska 1977.

[3]South Dakota Weeds, Agriculture Extension Service, South Dakota State University, March 1967.

[4]The Potential Cost of Spotted Knapweed to Montana Range Users, Cooperative Extension Service, Montana State University, Bozeman, Montana, Bulletin 1316, December 1984.

[5]North Dakota Extension Service. 1986. Agricultural Weed Control Guide Circular W253, Revised.

MITIGATION MEASURES

The purpose of this section is to discuss preventive measures, treatment methods, and protective measures that would be used in a noxious weed management program. In addition to the five evaluation criteria listed as common to all alternatives (see Chapter I, Purpose of and Need for Action), the following measures will be taken during a weed treatment program. Forest Service manuals, manual supplements, and field guides provide a variety of approved standard and special provisions. These provisions are updated periodically as pre- and post-treatment analysis finds a need for change.

Before any vegetation treatment or ground disturbance, Forest Service policy requires a survey of the project site for plants and animals listed or proposed for listing as threatened, endangered, and sensitive species (see Glossary). If a project might affect any listed or proposed Federal threatened or endangered species or its critical habitat, the Forest Service would modify, relocate, or abandon the project to obtain a no jeopardy determination. If it is determined that a project cannot be altered or abandoned, formal consultation would be initiated with the U.S. Fish and

Wildlife Service (50 CFR 402; Endangered Species Act of 1973, as amended). The Forest's policy of informal consultation on any project with the potential to affect threatened and endangered species will continue. In addition, plants identified as "unique" (see Appendix H) will be recognized and avoided by methods that threaten the habitat.

Developed recreation sites and concentrated use areas that are treated with herbicides will have signs posted stating the chemical used, date of application, and a contact number for more information. Signs will remain in place for at least 2 weeks after spraying.

In the Absaroka-Beartooth Wilderness, the Regional Forester may approve plant control (FSM 2323.24b) only for: (1) native plants when needed to maintain livestock grazing operations where practiced prior to the designation of wilderness; and (2) noxious farm weeds by grubbing or with chemicals when they threaten lands outside wilderness or are spreading within the wilderness, provided control can be affected without serious adverse impacts on wilderness values.

Weed control efforts such as prescribed fire, tilling, or other ground disturbing activities have the potential to adversely affect significant cultural resources. Cultural resource inventories will precede any ground disturbing activities (FSM 2360). Cultural sites discovered during pre-project surveys will be protected in accordance with appropriate Federal regulations (36 CFR 800).

The Forest Service will assure that noxious weed infestations are noted and considered during appraisals of any land proposed for exchange.

All projects will be supervised by certified personnel trained in application and handling of herbicides. Personnel supervising or using restricted-use herbicides shall be certified and licensed according to the Department of Agriculture's applicator certification plan which provides for either Federal or state certification by state agencies with approved plans. An annual action and safety plan will be prepared at the Ranger District level.

Herbicide application for noxious weed control will be accomplished by hand and ground equipment. Application rates will be within identified limits of the health risk analysis. Only herbicides registered with the Federal and state agencies for use on the targeted species will be used. All label requirements regarding herbicide use will be carefully followed, including safe storage and handling procedures.

Extreme care must be exercised in herbicide applications in and adjacent to the hardwoods, woody draws, and riparian areas. Application techniques will be utilized to prevent broad scale application, and individual plant treatment will be employed. No broadcast spraying will be allowed within 50 feet of riparian areas. All spraying inside 50 feet of hardwoods, woody draws, and riparian areas will be done by appropriate methods that minimize contact with nontarget vegetation (i.e., hand applicators or CDA's), following labeling precautions. Generally, no herbicide will be introduced directly into open water.

No spraying of liquid formulations will be done if temperatures are above 80 degrees F. or if the wind velocity exceeds 10 miles per hour or per labeling precautions. Winds will be monitored on the site during herbicide application. Boom pressures will not exceed 30 psi to minimize wind drift.

Records of herbicide use will be recorded daily in a herbicide use log, including: temperature, wind speed, and direction; herbicide and formulation uses; quantity of herbicide and diluent applied; location and method of application; acreage; and persons applying herbicides.

Noxious weed infestations will be inventoried periodically, as needed, to monitor existing infestations and identify new infestations. Pre- and post-evaluation will be completed on all herbicide projects. Monitoring will be done on all projects regardless of who did the actual work.

These management requirements and constraints apply to both in-Service and out-Service personnel treating noxious weeds on National Forest System lands.

EVALUATION OF THE ALTERNATIVES AGAINST THE EVALUATION CRITERIA

This section analyzes each of the alternatives against the evaluation criteria. The full discussion of the evaluation criteria appears in Chapter I, Purpose of and Need for Action. The criteria are briefly summarized:

Evaluation Criteria 1: Does the alternative meet the Forest's goal of integrated pest management program for noxious weeds?

Evaluation Criteria 2: Does the alternative aid in improving overall vegetative condition?

Evaluation Criteria 3: Does the alternative have significant adverse effects on key wildlife or fisheries species habitat?

Evaluation Criteria 4: Does the alternative have significant adverse effects on nontarget vegetation (forbs, shrubs, and trees)?

Evaluation Criteria 5: Does the alternative stay within the identified tolerable level of human health risk for herbicides?

Evaluation Criteria 6: Does the alternative effec-

tively limit the spread of noxious weeds on National Forest System lands and prevent spreading to adjacent lands of other ownership?

Alternative 1 - No Action

EC1: This alternative does not meet the objective of implementing a integrated pest management program as there would be no treatment of noxious weeds.

EC2: This alternative does not meet the intent of improving vegetative conditions. As the spread of noxious weeds continues across the Forest, there will be a decline in range condition and production. The noxious weeds will eventually invade most, if not all, range sites no matter what present conditions are.

EC3: Because no treatment of noxious weeds would occur, the quality of habitats for wildlife would not be affected significantly in the short term (0-5 years). Nontarget plant species would not be impacted. In the long term, 10 years and beyond, wildlife habitats would be affected as noxious weeds invade more area, out competing desired forage species. The unchecked spread of noxious weeds could degrade the quality of riparian zones and aquatic environments through loss of shrubs along streambanks. The increase of noxious weeds and the loss of shrubs could increase temperature gradients in the stream through the reduction in shade. Effects on cold water fish, notably trout, could be the loss of suitable habitat due to temperature increases.

EC4: Nontarget vegetation would not be affected under this alternative as no treatment would occur. The vegetative composition of the Forest, particularly the grasslands, will change due to the unhampered competitiveness of the noxious weeds.

EC5: There would be no risk to human health from herbicides by implementing this alternative.

EC6: This alternative would not limit the spread of noxious weeds on Federal lands. Thus, noxious weeds would likely spread within the Custer National Forest and onto adjacent lands.

Alternative 2

EC1: This alternative would meet and most likely exceed the Forest's goal of noxious weed treatment as all known infestations of noxious weeds on the Forest would be treated and all viable methods would be employed.

EC2: This alternative would aid in improving vegetative condition across the Forest. As noxious weed control occurs and the occurrence of noxious weeds decreases, desirable vegetation species would replace them. Depending on the method of treatment, such as burning, some short-term degradation of desirable species might occur; however, some species are stimulated by burning. Some ecosystems such as woody draws or riparian, might show a loss of woody vegetation because of the selected treatment method.

EC3: Under this vigorous attempt to control noxious weeds, the quality of wildlife habitats would be affected on the acres treated in the short term (0-5 years). Some loss of forage would occur, and some nontarget species might be impacted. Some increase in sedimentation would likely occur due to temporary loss of plant cover for the growing season following treatment. While the acres currently containing noxious weeds is a relatively small percentage of the total Forest Service acres, the attempt to eradicate these weeds would produce a short-term impact. In the long term (10 years and beyond), the eradication of noxious weeds would remove the threat of losing quality habitats due to the increase of desirable plant species. In summary, there would be a short-term impact and the potential for a long-term gain.

EC4: Because of the widespread nature of the treatment program under this alternative, forbs and shrubs would be affected because of their susceptibility to chemical or mechanical treatment. In time, it would be expected that some of these nontarget species may recover, others may not.

EC5: While the tolerable limits of human health risk would be respected, the chances of error, exposure (more workers) and accident would be greater with the amount of treatment required by this alternative.

EC6: This alternative would be very effective in limiting the spread of noxious weeds.

Alternative 3

EC1: This alternative would not meet the integrated pest management goal. The opportunity to clean up a priority area or drainage would be foregone resulting in denser populations of noxious weeds in areas where presently large infestations occur.

EC2: This alternative would allow some improvement in vegetative conditions of the Forest in the areas treated. The areas of larger infestations would continue to decrease vegetative condition as the occurrence of noxious weeds becomes more dense.

EC3: Because noxious weed control would be accomplished through herbicide methods, in the short term (0-5 years), some impacts to wildlife habitats would occur on those acres treated. The

impact to nontarget species would be limited, and a small amount of increased sedimentation would be expected due to the loss of plant cover immediately following treatment, the amount of which will be less than in Alternative 2. The loss of habitat quality that has occurred on acres currently dominated by noxious weeds will continue. In the long term (10 years and beyond), the potential loss of quality habitat due to the spread of noxious weeds would be minimized. Localized impacts would occur as treatment continues annually.

EC4: This alternative would impact some nontarget vegetative species on the localized areas treated. Due to the scale of the program, it is expected that the Forestwide impact would be minimal.

EC5: The identified limits of health risk would not be exceeded. Due to the restricted nature of the treatment program in this alternative, the opportunity for error, exposure or accident is likewise limited.

EC6: This alternative would effectively limit the spread of noxious weeds, where treatment occurs. Overall reduction of the larger infestations would not occur and it would be likely that these infestations will become more dense within itself as only the edges are treated.

Alternative 4

EC1: This alternative would meet the Forest's goal of implementing an integrated pest management program. This alternative offers a significant opportunity to reduce overall noxious weed infestations by controlling new starts, minor infestations and priority areas.

EC2: This alternative would meet this criterium, with local short-term adverse impacts. Overall condition is expected to improve as more desirable plants inhabit the area. Likewise, vigor of plants should improve.

EC3: Under this alternative, the intent is to prevent the spread of noxious weeds and eradication of localized populations. Control would be accomplished through a mix of chemical, mechanical, and biological treatments. Chemical treatments would dominate due to limited effectiveness of mechanical treatments and the current lack of biological agents for control. Impacts to wildlife habitats would be similar to Alternative 3, except that short-term impacts would be slightly higher due to the increase in acreage treated, and the long-term benefits would be higher due to the reduction of acres dominated by noxious weeds. If biological control becomes available, the short-term impacts would be reduced while long-term benefits would remain the same.

EC4: This alternative would impact some nontarget vegetation species. As priority areas are treated and controlled and new ones identified, the total amount of nontarget species would increase over time.

EC5: The application levels in this alternative would be within tolerable limits of health risk. However, the possibility of error increases with acres treated.

EC6: This alternative would effectively limit the spread of noxious weeds where treatment occurs. Overall reductions of large infestations would occur over time. The reduction in noxious weed would occur as control methods are implemented in priority areas.

Alternative 5

EC1: This alternative would meet a part of the goal to implement an integrated pest management program by offering an opportunity to release biological control agents in the large infestations and implement mechanical methods. Biological agents do not tend to be effective in small infestations as the agents require adequate food and habitat sources in order to survive and grow. Mechanical methods, such as mowing, burning or sheep grazing can be utilized in either large or small infestations.

EC2: At the present time with known biological and mechanical methods, vegetative conditions are not likely to improve. As technology develops and biological agents become more available for all target species, the effectiveness of these methods is expected to improve.

EC3: This alternative is similar to Alternative 3 except that only mechanical and biological treatments would occur. Mechanical treatments will affect nontarget plant species in the short term. Burning impacts all species in the short term, but may increase the amount and vigor of desirable species in the few years following burning. In the short term, greater impacts to wildlife habitat would occur due to the nonselective nature of the treatments and the limited effectiveness of these treatments will probably result in an increased number of applications in the same acre. Long-term benefits are similar to Alternative 3.

EC4: This alternative would have limited adverse effect on nontarget vegetation. Biological control agents are subject to clearances for use by State Departments of Agriculture and the Federal government to prevent impacts to nontarget vegetation and human health. Some forms of mechanical control, such as burning and mowing, may have a short-term detrimental effect on nontarget species. Most nontarget vegetation would likely recover.

EC5: Under this alternative no risk to human health would occur because of the elimination of any herbicide treatment.

EC6: This alternative would not likely prevent the spread of noxious weeds. Effectiveness of biological and mechanical control at the present time is limited, especially in the short term (less than 20 years). It is expected that implementing this alternative would in fact increase the acres of noxious weeds until the biocontrol agents established a population and other techniques became available.

Alternative 6

EC1: This alternative of a total herbicide program would not meet the Forest's goal of implementing an integrated pest management program. Opportunities to explore biological and mechanical methods would be foregone.

EC2: This alternative would most likely meet the objective of improving vegetative conditions. As the occurrence of noxious weed decreases across the Forest, there would be an increase in desirable plant species and production.

EC5: All herbicide applications would be within the tolerable limits although a greater risk is assumed with this alternative due to the opportunity for error, accident and worker exposure.

EC6: This alternative would effectively limit the spread of noxious weeds because of the known effectiveness of herbicide applications and the strategy to treat the infestations.

EC3: This alternative is similar to Alternative 4 except that only chemical treatments would be made. Benefits and impacts to wildlife habitats are similar to Alternative 4 except that the exclusion of biological control would eliminate the possibility of minimizing short-term impacts should an effective agent become available.

EC4: This alternative would likely adversely affect some nontarget plants. The widespread nature of this alternative would affect forbs, shrubs, and trees known to be susceptible to herbicide applications. Some of the effects would be short-term with recovery expected. In other situations, nontarget vegetation would not likely recover.

ALTERNATIVE COMPARISON CHART

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
AIR QUALITY	No smoke or particulates	Moderate, short-term emissions, but not to exceed air quality standards.	No smoke or particulates	Moderate, short-term emissions, but less than Alternative 2. Air quality standards will not be exceeded.	Greatest emissions (smoke and particulates) from burning of the 6 alternatives	No smoke or particulates
SOILS	No impact	High potential for short-term, insignificant surface erosion from herbicide application and mechanical treatments; long-term negligible	Moderate potential for insignificant soil impacts from herbicide application	Moderate potential for insignificant soil impacts from herbicide application	Moderate to low potential for insignificant soil impacts from mechanical treatment methods	Greatest potential for short-term, insignificant surface erosion from herbicide application; long-term negligible
WATER	No impact from treatment methods	Low probability of detectable herbicide. Insignificant short-term sedimentation from mechanical treatments.	No detectable herbicide levels	No detectable herbicide levels. Insignificant effect from mechanical treatment.	No impact due to herbicides or biological; no significant impact from tilling or other mechanical treatments	Low possibility of detectable herbicides
VEGETATION	Unchecked spread of noxious weeds reduces vegetative diversity and vigor; reduction of desirable plants, including nontarget; invasion of djacent land unrestricted	Excellent weed control with high potential to damage of nontarget species, more abundant grasses, invasion of adjacent lands well restricted	Good weed control on areas treated with moderate potential to damage nontarget species because of reduced acreage; invasion of adjacent lands moderately limited	Good weed control with moderate potential to damage nontarget species by prescribed burning; minimum impact from biological treatment	Fair weed control by mechanical methods with high potential to damage nontarget species by prescribed burning; minimum impact from biological treatment	Good weed control with moderate potential to damage nontarget species; more abundant grasses; invasion of adjacent lands well restricted

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
LIVESTOCK	Weed spread unchecked and reduce desirable forage. Some physical harm from ingestion of poisonous weeds. No impact from chemicals in herbicides.	Provides most improved forage; most chemical exposure to livestock of all alternatives	Provides some improved forage; limited chemical exposure to livestock	Provides improved forage to a greater extent than Alternatives 3 and 5; some chemical exposure to livestock	Provides little improved forage due to ineffectiveness of treatment; no chemical threat to livestock	Same as Alternative 2 except that chemical exposure is reduced because of reduced acreage
WILDLIFE	No direct effect to wildlife; habitat could suffer as infestation spread and compete with native vegetation	Greatest potential to affect habitat by berbicide and mechanical treatments; insignificant impact Forestwide	Limited potential to affect habitat or animals; insignificant Forestwide	Short-term habitat impact; insignificant Forestwide	Short-term limited habitat disruption; insignificant Forestwide	Short-term habitat impact: insignificant Forestwide.
FISH	No impact	Low probability of any effect due to riparian, open water and label restrictions; short-term sedimentation potential	Low probability of any effect due to riparian, open water and label restrictions; short-term sedimentation potential	Low probability of any effect due to riparian, open water and label restrictions; short-term sedimentation potential	No significant impact; some short-term impact on streamside vegetation from burning	Low probability of any effect due to riparian, open water and label restrictions; short-term sedimentation potential
CULTURAL RESOURCES	No probability for site damage	Low probability of site damage	Low probability of site damage	Low probability of site damage	Some probability of site damage due to mechanical treatments	Low probabilify of site damage
VISUAL AND RECREATION	No visual impact; some recreation setting disturbed by stickers and latex	Some short-term visual disturbance may be reoccurring; good improvement some recreation setting with infestation	Little visual disturbance; little effect on recreation sites	Some short-term visual disturbance; good improvement at recreation sites with treated infestations	Little to no visual disturbance from biological methods; some short/long-term reoccurring visual disturbance from tilling/burning; little effect on recreation setting	Some short-term visual disturbance; good improvement at recreation sites with treated infestations
WILDERNESS	Current small infestation will continue to spread	Effective control of small infestations; limited effect on wilderness characters; needs Regional Forester approval	Effective control of small infestations; limited effect on wilderness characters; needs Regional Forester approval	Effective control of small infestations; limited effect on wilderness characters; needs Regional Forester approval	Ineffective methods for small infestations; needs Regional Forester approval	Effective control of small infestations; limited effect on wilderness character; needs Regional Forester approval
SOCIO-ECONOMIC CONDITIONS	Continued spread of noxious weed seriously impact viability of rancher and stockmen; loss of grazing capacity and increased animal death	Decrease economic losses, increased viability of ranches; stockmen; Benefit local economies; good restriction of noxious weed spread to adjacent lands	Limited economic improvement; containment of noxious weed infestation	Moderate economic improvement; containment and control of noxious weed infestations	Spread of noxious weeds would continue and impact viability of ranchers and stockmen; these methods may reduce infestations over the long-term (20+ years)	Same as Alternative 4
HUMAN HEALTH	No additional health risk from weed treatment	High potential for worker exposure to herbicides; applications within tolerable limits	Moderate potential for worker exposure to herbicides due to area treated and IPM methods	Moderate potential for worker exposure to herbicides due to area treated and IPM methods	No potential for worker exposure to herbicides; some risk involved with mechanical methods such as burning or tilling	High potential for worker exposure; applications within tolerable limits

IDENTIFICATION OF THE PREFERRED ALTERNATIVE

The Forest Service preferred alternative is Alternative 4. It is preferred because it is an integrated pest management program and meets the intent of the Forest's goal for noxious weed control. It is not the most effective approach to noxious weed control, but it does offer a manageable, low-risk program.

There is a good opportunity to eliminate the spread to adjacent lands, although some infestations on National Forest System lands may become denser as only the perimeters would be treated. This is an acceptable consequence given the undesirable level of treatment needed to totally control (eradication) noxious weed infestations. A particular benefit of Alternative 4 is the opportunity to identify "priority areas" that will be targeted for control, i.e. attempts to eradicate the weeds on the interior of the infestation. Alternative 4 additionally provides the opportunity to continue cooperative research efforts with biological control agents, especially in environmentally sensitive areas. It is believed that this alternative will aid in maintaining and improving overall vegetative conditions for livestock as well as wildlife and fish habitats. The detrimental impacts to nontarget vegetation is within acceptable limits. The human health risk is also within acceptable levels and is certainly well-below any expected toxic or carcinogenic potentials.

CHAPTER III
AFFECTED ENVIRONMENT

This chapter describes the environment of the areas to affected by the alternatives under consideration.

GENERAL SETTING

Lands under Custer National Forest management total 2,445,798 acres; 1,185,680 acres are proclaimed National Forest lands and 1,260,118 acres are National Grasslands. An additional 1,552,958 acres of non-Federal lands lie within the boundaries of these National Forest System lands, making the gross area within the Forest's boundaries 3,998,756 acres.

These lands lie within 20 counties in Montana, North Dakota and South Dakota. They are scattered from the northeast corner of Yellowstone National Park in Park County, Montana, to Richland County in the southeastern corner of North Dakota. Distances involved are about 240 miles north-to-south and 650 miles east-to-west.

TABLE III-1

LAND STATUS

National Forest Proclaimed lands	1,186,391 acres
National Grasslands	1,260,118 acres
Non-Federal Within Boundaries	1,552,374 acres
Gross Area	3,998,756 acres
Net National Forest System lands	2,446,379 acres

PHYSICAL SETTING

Topography

The Custer National Forest contains a wide variety of geologic settings, ranging from the igneous-metamorphic rocks of the Beartooth Mountains, to deep sedimentary basins, to areas of continental glaciation. Elevations range from 905 feet above sea level in the eastern end of the Forest to 12,799 feet above sea level in the west end of the Forest.

The Sheyenne National Grassland is located beyond the eastern border of the Williston Basin in eastern North Dakota and overlies the Sheyenne Delta. This land was deposited as the Sheyenne River flowed into ancient glacial Lake Agassiz. The average elevation on the Sheyenne is about 1,050 feet above sea level and there are only a very few places more than 50 feet higher or lower than that.

The Grand River and Cedar River National Grasslands in North and South Dakota are located on the southeastern portion of the Williston Basin and overlie approximately 10,000 feet of sedimentary formations. Surface formations consist of the Ludlow and Cannonball members of the Fort Union Group which is Paleocene in age.

The Little Missouri National Grassland in western North Dakota is located in the south-central portion of the Williston Basin and overlies approximately 14,000 feet of sedimentary formations. The formations exposed at the surface consist of the Golden Valley (Paleocene-Eocene), the Sentinel Butte, and the Bullion Creek (Paleocene) formations.

The Denbigh Experimental Forest lies in north-central North Dakota in McHenry County. Currently about 60 acres are planted to trees. The remainder of the area, primarily the northeastern quarter and the southeastern quarter, is natural prairie vegetation, including several prairie grasses and small clumps of native aspen. In addition, a "natural forty" has been administratively set aside and reserved for botanical studies. Management of this area is cooperatively accomplished by the Custer National Forest of the Northern Region of the Forest Service and the Rocky Mountain Forest and Range Experiment Station.

The Souris Purchase Unit, a 160 acre tract, is located in McHenry County in north-central North Dakota and is adjacent to the North Dakota State Forest Service nursery. A portion of this grassland area has been used for haying, while another portion of the Unit is used for pine and juniper privence (origin) studies through the Rocky Mountain Forest and Range Experiment Station.

The Sioux Ranger District in South Dakota and Montana is located on the southwest portion of Williston Basin and near the Miles City Arch. The District is composed of a group of erosion remnants made up of buttes left standing above the surrounding land surface. Exposed at the surface are mainly the Ludlow and Cannonball formations.

The Ashland Ranger District in Montana is composed of the Tongue River member of the Fort Union Formation. It consists of nearly level bedded, weakly consolidated sandstones, silty sandstones, clayey shales, lignite beds and porcellanite (locally called scoria) and clinker beds. This District is located in the north-central portion of the Powder River Basin.

The Beartooth Ranger District in Montana contains the Beartooth and Pryor Mountains. The Beartooth Mountains are a massive block of Pre-

cambrian crystalline rock, including the Stillwater Complex, that was thrust up through and over about 11,000 feet of Paleozoic-Mesozoic sedimentary rock with subsequent faulting and folding.

Climate

The climate of the Custer Nationa1 Forest is Continental, which means that summers are short and hot and winters are long and cold. Temperature extremes are also broadened by great elevation differences. Temperature regimes range from temperate to subartic. Moisture regimes vary from subhumid to semi-arid.

Precipitation generally rises on Districts farther east from the mountains; the Sheyenne National Grasslands receive more precipitation and its ambient relative humidity is much greater than on the higher plains of eastern Montana and western Dakotas. Mountainous areas of the Beartooth District are an exception in that annual precipitation in some areas exceeds 70 inches.

Visual Setting

The landscape and its components that make up the visual resource of the Custer National Forest span five landscape character types within Montana, North Dakota, and South Dakota. These types are called Yellowstone Rockies, Rocky Mountain Foreland, Big Dry, Middle Missouri, and Red River, and are described in the USDA, Forest Service, Region 1 Publication, *Visual Character Types and Variety Class Descriptions.*

The National Forest System lands range from the lush, tall-grass prairie of eastern North Dakota, across the dry, mixed-grass prairies and awesome badlands of western North Dakota, and on westward to the islands of pine in a sea of grass in northwest South Dakota and southeastern Montana. From there west, the mountains and the associated vegetation and landform seem to grow and grow until the 10,000 plus foot Beartooth Mountains appear. With such drastic and extreme differences in landform, vegetation, rock form, and waterforms, it is nearly impossible to draw any conclusions regarding the quality or quantity of any one landscape.

The existing visual condition (EVC) of the Custer National Forest is generally classified Untouched, Unnoticed, or Minor Disturbance (Classes 1, 2, and 3, respectively). However, in 1980, 122,189 acres, or roughly 5 percent of the Forest, was classified as EVC Class 4 - Disturbed. For the most part, management activities to date have not been to a scale that the impacts have dominated the natural landscape.

Soils

The lands administered by the Custer National Forest have a great variety of soils. The variation

TABLE III-2

LANDFORMING PROCESSES AND RESULTANT SURFACE SOILS

Ranger District	Soil Orders Represented	Parent Material	Landforming Processes
Sheyenne	Mollisols, Entisols	Lacustrine sands of fluvio-glacial origin	Lacustrine deposition and recent wind shaping
Beartooth	Mollisols, Entisols, Inceptisols, Alfisols, Histosols	Granitic and sedimentary bedrock, granitic till and fluvio-glacial outwash	Glacial scour, fluvio-glacial deposition, frost cyroplanation, pluvial degradation
Sioux	Mollisols, Entisols, Aridisols, Alfisols	Sedimentary bedrock, fluvial deposits	Pluvial degradation, fluvial deposition
Ashland	Mollisols, Entisols, Aridisols, Alfisols	Sedimentary bedrock, fluvial deposits	Pluvial degradation, fluvial deposition
Grand River	Mollisols, Entisols, Aridisols, Alfisols	Sedimentary bedrock, few fluvial deposits	Pluvial degradation, fluvial deposition
Medora and McKenzie (Little Missouri Nat. Grasslands)	Mollisols, Entisols, Inceptisols	Sedimentary bedrock, some fluvial deposits, some glacial till	Pluvial degradation (active and rapid) (in badlands), fluvial deposition.

should be expected in view of the distances and diverse areas represented. Surface materials range from coarse glacial till and scoured bedrock in the Beartooth Mountains to finer textured silty and clayey soils in eastern Montana and the western Dakotas. Sandy glacial outwash soils occur on the Sheyenne National Grassland in eastern North Dakota.

Mean annual soil temperatures range from about 50 degrees Farenheit on the warmest sites down to 30 degrees Farenheit or lower on permafrost soils of the high Beartooth Mountains. Moisture regimes vary from permanently saturated (acquic) organic soils to near-desert (aridic) soils which are dry for more than half the year. Most are in intermediate categories.

Silty and clayey soils with moderate to strong horizon development are typical of most of the land from the Pryor Mountains eastward to the National Grasslands of the western Dakotas. Wind erosion is a problem on much of the National Grasslands, particularly in the Sheyenne National Grassland with its light sandy soils. Some wind erosion has occurred on alpine portions of the Beartooth Mountains. The Badlands exhibit rapid rates of natural geologic erosion. Large volumes of runoff generate unusually large volumes of sediment there because of poor infiltration and the lack of vegetative cover.

More than 90 percent of the Custer National Forest is mapped and published in Soil Surveys by the National Co-op Soil Survey. The Forest soils are identified as being within six of the ten World Soil Orders. It is likely there are also small undocumented units of Vertisols, which would leave only three Orders unrepresented. Geologic parent material influenced by landforming processes over a period of time have created surface soils in the Orders listed in Table III-2.

Certain soil families and series within these Orders are more susceptible to damage than others. For example, on the Beartooth District, the high altitude soils are slow to recover following disturbance and thus require considerable care for any type of use, even for wilderness recreation uses. The Pryor Mountains in the same Ranger District are generally quite stable, but soils formed in parent material of the Chugwater Formation are hard to protect because they often support only sparse vegetation and they are difficult to revegetate.

Table III-2 shows the landforming process and resultant surface soils for each of the Ranger Districts on the Forest.

Watershed

Currently, about 1,091,500 acre feet of water annually run off the Custer National Forest system lands. Ninety-five percent of that water meets or exceeds minimum quality standards. The remainder has excessive sediment due to natural erosion or to excessive dissolved salts from certain highly saline soils.

Water quality and quantity can usually be affected by management of the lands surface and its vegetative cover. The badlands of North and South Dakota are an exception because the soil normally cannot be vegetated in order to reduce sediment production. Most of the other runoff water in the Forest originates in the Absaroka-Beartooth Wilderness where very little human activity occurs which could affect quantity or quality of runoff.

Thirty percent of the land on all except the Sheyenne and Beartooth Districts is badland or similar ecosystems. Most of this land is located where runoff is about 50 acre feet annually/square mile (less on the Ashland District). If the badland ecosystem produces 50 percent more runoff than the well-vegetated units (1.5 inches versus 1 inch per year), which seems a conservative estimate in view of surface conditions, then they produce at least 50,000 acre feet annually. This water is below minimum quality standards and there is no feasible way nor a valid reason to attempt to improve its quality. Sediments from this water are deposited in downstream reservoirs where storage capacities are slowly reduced by the accumulations.

BIOLOGICAL SETTING

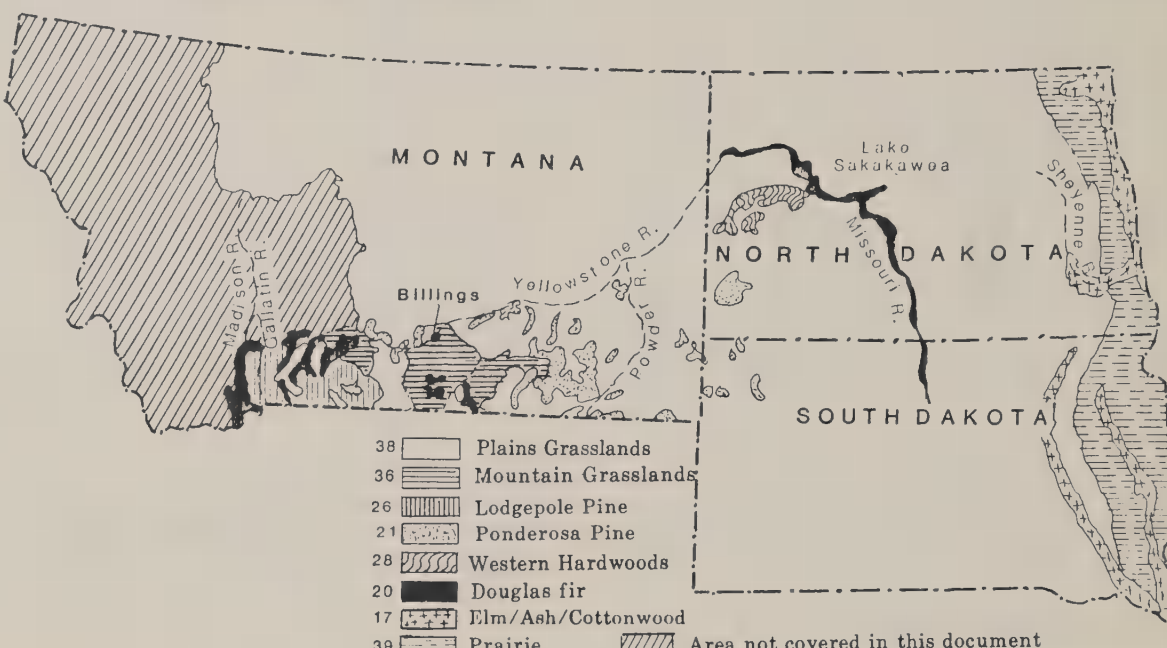
The Custer National Forest has characterized its lands and stratified their capabilities on the basis of ecosystems.

Ecosystems consist of a complex of living and nonliving components, each interacting with the others to function as an integrated system or unit. While each of the individual components (i.e., soil, plants, water, microorganisms, and wildlife species) has its own significance, it is the combined effect of all and the interactions among them that are important. It is the total complex rather than the individual components that governs production possibilities and limitations, defines technical problems, and determines the appropriate types and intensities of uses of the area by man.

The environment on the Custer National Forest has been evaluated on the basis of grouped ecosystems. The ecosystems were described and delineated on the basis of landforms, topographic characteristics, and vegetative types. The general categories of environmental settings used in this analysis were riparian, grasslands, grass/tree and grass/shrub, and forested.

The following map of Montana, North Dakota and South Dakota is taken from the publication

"Vegetation and Environmental Features of Forest and Range Ecosystems", USDA Agriculture Handbook No. 475. The map indicates the vegetative diversity across the Custer National Forest. The numbers on the map correlate to the brief ecosystem descriptions that follow. More site-specific ecosystems have been defined for most of the Custer National Forest and are available for review at the Forest Supervisor's office or at the individual Ranger District offices. For the purposes of this analysis, the broader ecosystems indicated here were determined to be more appropriate. More complete definitions for these ecosystems indicating climate, fauna, and soils and in many instances, approximation of herbage and browse production, can be found in the publication referenced above.



No. 17 — The Elm-Ash-Cottonwood Ecosystem

The vegetation of this ecosystem is a tree lifeform of low to all broad-leaved deciduous trees, varying from open to dense and often accompanied by vines. Cottonwood species usually dominate the ecosystem and often occur in pure stands. Cottonwood is most common along the streams. Common associates in the north are willow species and green and white ash.

No. 20 — The Douglas-fir Ecosystem

The Douglas-fir ecosystem is an extensive ecosystem, for there are large acreages of it in the Northern Rocky Mountains and lesser scattered areas in the Blue Mountains of Oregon and the Middle and Southern Rocky Mountains. The elevational range is great, from 500 feet up into the high mountains.

This ecosystem is characterized by forest consisting of 50 percent or more Douglas-fir. Common shrubs in the ecosystem are of the genera of snowberry, barberry, currant, blackberry, ninebark, rose, and spirea. Herbage includes grass and other vegetation having a grasslike growth form, especially in the stands in interior states.

No. 21 — The Ponderosa Pine Ecosystem

Since ponderosa pine has a rather wide range of adaptability and can dominate some of the less mesic true forest sites, it occupies low mountains and foothills in many places; yet in mixtures with other species, it is found at moderate elevations. It is the largest western forest type in the United States. By definition, ponderosa pine forest is 50 percent or more ponderosa pine.

This ecosystem is idealized as open and parklike with an excellent ground cover of grasses, sedges, and forbs or with an understory of shrubs of low to medium height. The mountain range of the ponderosa pine and Douglas-fir ecosystems is a prime summer range for a high proportion of the mule deer and is a spring and fall range for elk.

No. 26 — The Lodgepole Pine Ecosystem

The lodgepole pine ecosystem occupies sites on high mountains. It occurs even in some places where less than 20 percent of the area is gently sloping and at elevations ranging from 4,000 to 11,500 feet, with local relief over 3,000 feet. However, the ecosystem is best developed on gentle mountain slopes.

Ecologically, lodgepole pine stands are seral to some of the western interior coniferous forests. "Doghair" stands often develop after fires. Herbage production can be 0 to 50 pounds per acre in dense stands of 2,000 to 3,000 pounds per acre where clearcuts, burns, or conversions to a different coniferous stand are carried out. Of course, herbage productivity in treated areas declines with closure of the tree canopy and in 10 to 20 years will return to a very low level.

No. 28 — The Western Hardwoods Ecosystem

The western hardwoods ecosystem occurs in the Rocky Mountains, and this portion of the ecosystem (mostly aspen areas) varies considerably. The vegetation is a forest of low to medium-tall, broad-leaved deciduous or evergreen trees, sometimes with an admixture of low to medium-tall needle-leaved evergreens, often with an understody of grass and shrubs.

The widely scattered Rocky Mountain and plains states "hardwood" portion of the ecosystem consists primarily of quaking aspen stands with an understory of grasses, forbs, and shrubs. In many places where the aspen stands are inclusions within areas of sagebrush or conifers, they are important sources of food and cover for wildlife. Cottonwood becomes dominant on plains, more or less replacing aspen.

No. 36 — The Mountain Grasslands Ecosystem

The mountain grasslands ecosystem consists mainly of open, untimbered areas, yet it is often adjacent to or surrounded by ponderosa pine, Douglas-fir, or lodgepole pine at moderate elevations. At high elevations, the ecosystem is subalpine and is on mountain slopes or faces adjacent to spruce-fir forests and patches of alpine fir or whitebark pine. It also occupies some of the best drained soils of valleylike areas intermingled with mountains, and it occupies various foothills, tablelands, and low mountains. The higher mountain settings can be rich with streams and lakes.

It is characterized throughout by bunchgrasses of the fescue and wheatgrass groups. An abundance of desirable forbs appears to increase the productivity of some of the higher sites. At higher elevations, the grasslands are important summer ranges for big game and cattle, prime watersheds and recreation areas, and the traditional mountain settings of sheep and shepherds.

No. 38 — The Plains Grasslands Ecosystem

The plains grasslands ecosystem, also known as the Great Plains, occurs on a broad belt of high land which slopes gradually eastward and down from an altitude of 5,500 feet near the eastern foothills of the Rocky Mountains to an altitude of 1,500 feet in the central states, where it gives way to the prairie ecosystem. The most striking feature of the ecosystem is the phenomenal flatness of the interstream areas, which make up a great expansive fluviatile plain or alluvial slope. The plains grasslands ecosystem of 280 million acres is larger than any other vegetation region in the United States.

Short, warm-season grasses predominate in this ecosystem, and there is a minor interspersion of forbs and shrubs. Vast stretches are dominated almost exclusively by blue grama, buffalo grass being a companion in many areas. However, the eastern part of the ecosystem is dominated by grasses of medium stature, such as western wheatgrass and needlegrass. The occasional shrubs include juniper, silver sagebrush, silver buffaloberry, and skunkbush sumac in the northern reaches. Forbs are generally quite common, but many are ephemerals.

No. 39 — The Prairie Ecosystem

The prairie ecosystem is a relatively large contiguous grassland which lies between the deciduous forests of the East and the short-grass plains of the West, on the flat to rolling hill land of the Central Lowland. The area south of the Missouri River is older, has well-developed drainage systems, and is flat to rolling hill land.

The prairie ecosystem is known to many as the tall-grass or true prairie. Bluestems constitute about 70 percent of the vegetation and reach heights of 5 to 6 feet in lowland areas. Large numbers of flowering forbs are present but are usually overshadowed by the grasses. Most of the plants are classified as warm-season plants. Woody vegetation is rare. Willow occurs in some places in exceptionally moist areas of the northern part of the ecosystem.

NOXIOUS WEED INFESTATIONS

At the present time, the Custer National Forest has noxious weed infestations amounting to approximately 8,900 acres in North Dakota, South Dakota, and Montana. Table III-3 shows the levels of infestations. Generally speaking, the Custer's infestations are primarily leafy spurge (8,123 acres), spotted knapweed (613 acres), Canada thistle (70 acres) and hemp (40 acres). Dalmation toadflax, wormwood, sowthistle, and St. Johnswort also occur, but are small and sporadic.

There is a larger infestation in North Dakota (8,035 acres) than in Montana (782 acres) or South Dakota (83 acres). The following discussion describes the different weed infestations on the Forest. Wormwood, sowthistle, and St. Johnswort are not discussed as their infestation levels at the present time are very minor (10, 2, and 1 acre, respectively).

TABLE III-3

ACRES OF NOXIOUS WEEDS ON THE CUSTER NATIONAL FOREST

BY STATE

Species	Montana	North Dakota	South Dakota	Total
Leafy spurge	123	7,938	62	8,123
Spotted knapweed	598	5	10	613
Canada thistle	27	40	3	70
Hemp	0	40	0	40
Russian knapweed	21	0	8	29
Dalmation toadflax	12	0	0	12
Wormwood	0	10	0	10
Sowthistle	0	2	0	2
St. Johnswort	1	0	0	1
TOTAL	782	8,035	83	8,900

BY RANGER DISTRICT

Species	Sheyenne RD	Beartooth RD	Sioux RD	Ashland RD	Grand RD	Medora RD	McKenzie RD
Leafy spurge	5,163	3	150	0	32	2,500	175
Spotted knapweed	0	114	40	454	0	5	0
Canada thistle	5	6	10	14	0	5	30
Hemp	40	0	0	0	0	0	0
Russian knapweed	0	0	0	21	8	0	0
Dalmation toadflax	0	12	0	0	0	0	0
Wormwood	10	0	0	0	0	0	0
Sowthistle	2	0	0	0	0	0	0
St. Johnswort	0	0	0	1	0	0	0
TOTAL	5,220	135	200	490	40	2,510	205

Leafy Spurge

Leafy spurge is by far the predominant noxious weed on the Forest. Except for small patches in Montana and South Dakota, the major infestations are concentrated on the Sheyenne and Medora Districts in North Dakota (5,163 acres and 2,500 acres, respectively).

Even though the infestations seem major, they make up less than .5% of the Medora District and 7% of the Sheyenne District. Together with the McKenzie District infestation of 175 acres, these infestations make up 1% of the total North Dakota infestation estimated at 600,000 acres.

If left untreated, leafy spurge is estimated to spread vegetatively and reproductively at a rate approaching .25 acres per year. Recent studies conducted by NDSU show increased forage yields of over 250 percent following treatment of leafy spurge (Lym and Messersmith 1985). Unlike most noxious weeds, leafy spurge will invade rangelands in good condition and successfully out compete desirable species.

Knapweeds

Spotted or Russian knapweeds occur on four of the seven Districts, not occurring on the Sheyenne, Grand River, or McKenzie Districts. Most infestations, except for the Ashland District, are small. This spotted knapweed infestation is estimated at 454 acres and occurs in disturbed sites and tolerates a variety of environmental settings. On the Beartooth District, the majority of the spotted knapweed lies in the Stillwater and Rock Creek drainages adjacent to flowing water and a municipal watershed. If left uncontrolled, knapweed is a prolific seeder and spreads rapidly.

Canada Thistle

This weed generally grows on disturbed areas, i.e., roads or timber sales, and spreads by horizontal roots and seed. It can be found in meadows and pasture, also. It is much more serious on cultivated lands than in forested or rangelands. Canada thistle occurs on every District except the Grand River and McKenzie in infestations of 30 acres or less.

Dalmatian Toadflax

This noxious weed is a perennial, spreading by creeping roots and seeds and invades rangeland and mountain meadows. It occurs only in small isolated places on the Beartooth District. Approximately 12 acres are infested.

Hemp (marijuana)

This weed, an annual, occurs in small areas only on the Sheyenne District, totaling 40 acres. Its presence is a result of the World War II hemp-making industry. When the hemp market failed, the plant was allowed to grow wild. The plant is a prolific seeder and sprouts profusely when disturbed. It can be found in rich bottomland as well as around farm buildings, in pastures, road ditches, and fence rows.

Treatment

For several years the Custer National Forest has entered into cooperative agreements with the county commissioners and county weed control boards to accomplish noxious weed control on Forest System lands. However, Public Law 95-224 (Federal Grants and Cooperative Agreements Act of 1978) prohibited the Forest Service to enter into cooperative agreements. Attempts are being made to use provisions of the Carlson/Foley Act to again cooperate with county weed control boards.

Present control methods have been predominantly chemical. Chemicals used most often include 2,4-D (2,4-dichlorophenoxyacetic acid), Tordon 22-K (picloram), and a 2,4-D/picloram mix. In spite of acreages treated each year, the number of acres infested with leafy spurge and other noxious weeds has increased.

Present control objectives are to hold the rate of spread until more effective control methods are found and developed.

Chemical control of leafy spurge is only moderately effective for a number of reasons. Many of these are related to characteristics of the plant itself: long-term viability of the seeds, deep rooting (up to 15 feet in depth), and a high capacity to produce new shoots from roots (even through 3 feet of soil). Chemical control is complicated because of terrain, associated sensitive vegetation (nontarget), and human health risk.

Chemical costs for any alternative used are fairly high depending on rates of application and chemical used. These costs can be reduced by using less chemicals and new application techniques. Research is showing that in some cases, greater effectiveness can be achieved with a lower rate.

Picloram, glyphosate, 2,4-D, and dicamba are considered safe to livestock, wildlife, and man when applied at or below recommended rates following recommended procedures. The amount of herbicide which will leach through a soil is dependent on the chemical properties and many soil factors. A significant factor is the rate of adsorption. This is directly related to the clay content of the soil. In a semiarid environment, which is the case on most of the Forest, picloram, glyphosate, and 2,4-D will generally not leach out through the soil.

The various treatment methods are more thoroughly discussed in Chapter II, Alternatives, Including the Proposed Action.

DEMOGRAPHIC, SOCIAL, AND ECONOMIC CHARACTERISTICS

Population

The lands of the Custer National Forest and of the National Grasslands administered by the Custer National Forest occur in 20 counties of Montana, North Dakota, and South Dakota. Another 10 adjacent counties are within the zones of local influence of the Custer National Forest lands. These 30 counties are referred to as zone counties. In two other counties, the Custer National Forest administers small mineral acreages but no surface acreage, and these two are not considered here.

As shown by the demographic data in Table III-4, the total populations of these 30 counties in the 1980 census was 394,505. Of this total, 42 percent people were in the two metropolitan counties (Yellowstone County, Montana, and Cass County, North Dakota). Twenty-two of these counties have populations of less than 10,000 and 16 of those have populations of 5,000 or less. Thus, a "typical" zone-of-influence county has a population of about 7,000, with a county seat of perhaps 1,700, with various small settlements of between 40 and 800 people, and a rural population of about 3,000.

Between 1960 and 1970 the population of many rural counties decreased as larger farm equipment became more common and farm size increased. A number of the counties largely dependent on agriculture continued to decline, but counties experiencing energy development

TABLE III-4
POPULATION DATA BY DECADE

County	State	Population 1960	1970	1980
Beartooth District				
Yellowstone	MT*	79,016	87,367	107,661
Carbon	MT	8,317	7,080	8,099
Park	MT	13,168	11,179	12,660
Stillwater	MT	5,526	4,632	5,598
Sweetgrass	MT	3,290	2,980	3,216
Sioux District				
Carter	MT	2,493	1,956	1,799
Harding	SD	2,371	1,855	1,700
Ashland District				
Big Horn	MT*	10,007	10,057	11,083
Powder River	MT	2,485	2,862	2,520
Rosebud	MT	6,187	6,032	9,899
Sheyenne National Grassland (Sheyenne Ranger District)				
Cass	ND*	66,947	73,683	88,247
Ransom	ND	8,087	7,102	6,698
Richland	ND	18,824	18,089	19,207
Cedar River National Grassland (Grand River Ranger District)				
Adams	ND*	4,449	3,832	3,584
Grant	ND	6,248	5,009	4,274
Sioux	ND	3,662	3,632	3,620
Corson	SD	5,798	4,994	5,196
Perkins	SD	5,977	4,769	4,700
Zieback	SD	—	—	—
Little Missouri National Grasslands (Medora District)				
Billings	ND	1,513	1,198	1,138
Golden Valley	ND	3,100	2,611	2,391
Slope	ND	1,893	1,484	1,157
Stark	ND*	18,451	19,613	23,697
Bowman	ND*	4,154	3,901	4,229
Dunn	ND*	6,350	4,895	4,627
Fallon	MT*	3,997	4,050	3,763
Little Missouri National Grasslands (McKenzie District)				
McKenzie	ND	7,296	6,127	7,132
Williams	ND*	22,051	19,301	22,237
Richland	MT*	10,504	9,837	12,243
Denbigh-Souris Purchase Units				
McHenry	ND	11,099	8,977	7,858

*Zone of influence counties, not containing any National Forest system lands.

or experiencing growth as regional market centers generally have increased in population. Overall, the population grew 13.4 percent in the 1970-1980 period. Population increased in 29 towns and cities and decreased in the remaining 14.

The 1990 population projection assumes a continuation of three trends: (1) additional growth in counties experiencing significant oil, natural gas, and coal development; (2) modest growth of counties serving these energy-producing counties as wholesale, retail, and service centers; and (3) modest growth of the counties in the Beartooth District due to the retirement amenities they offer, the recreational opportunities, and possibly the hardrock mining activity that is again increasing.

Lifestyles

The population is largely rurally oriented, with strong ties to the land and to the many small towns. In both of the metropolitan counties, Yellowstone County containing Billings, Montana, and Cass County containing Fargo, North Dakota, the populations are roughly 65 percent urban and 35 percent rural.

Ranch and farm families constitute 25 percent or more of the populations of 17 zone counties. These long-time residents exert considerable political and economic influence, and tend to favor traditional land uses and the preservation of intergenerational family operations. Another 25 percent or more of the populations in a majority of the counties are long-established small town residents.

Another 10 percent of the populations outside of the two metropolitan counties are Native Americans, and largely are residents of five different Indian reservations in or near the zone counties.

In recent years, the areas of major mineral activity have seen an influx of people from other areas. Many of these people regard their employment as temporary, expect to move on to other areas, and usually do not play an integral part in community affairs.

Another distinct group is a small but growing population of professionals, craftsmen, retirees, and others who have moved to small towns (particularly in the forested counties) to enjoy the slower pace of life and various amenities.

Lastly, the two metropolitan counties (Yellowstone County, Montana, and Cass County, North Dakota) are growing areas, with a wide diversity of business, manufacturing, transportation, medical, educational, and cultural components, as well as significant agricultural components outside of the immediate metropolitan areas. The populations of these two cities are cosmopolitan when compared to the rural areas and smaller towns, and have attracted people from many parts of the Nation. The people of these cities view the National Forest and National Grasslands primarily as valuable recreational areas rather than as integral parts of their economies.

Economy

In the majority of the zone counties, agriculture and its related support services are the primary economic base. A few counties are experiencing high oil, natural gas, and/or coal development. However, their agricultural activities are still the long-term bases of their economy. The two metropolitan counties have business, manufacturing, professional services, and other economic foundations, as well as the agricultural components.

The average 1981 per capita income of people in the 26 rural zone counties for which complete data were available was $9,585, compared to the average of $9,495 for the three states (Montana, North Dakota, and South Dakota), and the average of $10,766 for the two metropolitan counties. However, when one converts the 1973 and 1978 per capita data into 1981 constant dollars, the changes reveal a general trend that indicates that per capita income increases are not keeping pace with inflation.

Considering these 26 rural counties and converting all available data to 1981 dollars, the 1973 to 1978 changes show only three counties with per capita gains, and 23 counties with losses. The 1978 to 1981 data reverses that trend with 18 counties showing gains and eight showing losses.

Table III-5 shows the average income by county grouping for the years 1973 through 1981.

Forest Receipts

Forest receipts by resource for 1979 through 1983 by selected years are shown in Table III-6.

The future economic situation for most of the zone counties will continue to be dependent on the stability of the agricultural base. For the counties producing oil, natural gas, and coal, those resources dominate the revenue picture at present, but they represent resource revenues that can fluctuate rapidly, and do not in any way negate the value of the long-term, relatively stable foundation of the renewable resources, particularly agriculture. Further, only a small percentage of the people in the energy resource counties are actively engaged in energy development. As a consequence, one must not in any way discount or overlook the economic significance of the renewable resources, even though at present they are vastly overshadowed by the mineral resource revenues in those energy counties.

TABLE III-5

AVERAGE INCOME DATA

	Dollars Per Year			Value in 1981 Dollars		
	1973	**1978**	**1981**	**1973**	**1978**	**1981**
Metropolitan Counties						
Yellowstone, MT	5,578	8,893	10,946	10,291	11,534	10,946
Cass, ND	6,797	9,131	10,586	12,540	11,842	10,586
Average for the 26 largely rural counties						
Nat'l Forest Zone	5,955	6,702	8,944	10,987	8,693	8,944
Nat'l Grassland Zone	6,581	7,098	9,869	12,142	9,205	9,869
Rural Average	6,388	6,976	9,585	11,787	9,047	9,585
State per capita averages						
Montana	5,441	7,528	9,412	10,038	9,763	9,412
North Dakota	6,368	7,683	10,237	11,748	9,964	10,237
South Dakota	5,372	6,992	8,837	9,911	9,068	8,837

TABLE III-6

REVENUES BY RESOURCE CATEGORIES
(values in thousands of dollars)

	Grazing	Timber	Minerals	Other	Total
National Forest Districts:					
FY 1979	319	12	2	44	376
FY 1980	420	14	8	53	495
FY 1981	305	20	5	52	383
FY 1982	307	2	21	76	406
FY 1983	237	2	78	121	438
National Grassland Districts:					
CY 1979	314	1	5,384	403	6,101
CY 1980	820	0	21,587	56	22,464
CY 1981	805	0	41,121	261	42,187
CY 1982	810	0	36,274	317	37,402
CY 1983	1,102	0	32,554	261	33,918
Total Forest:					
1979	633	12	5,386	446	6,478
1980	1,241	15	21,595	109	22,959
1981	1,110	20	41,126	313	42,570
1892	1,118	2	36,295	393	37,808
1983	1,339	2	32,632	382	34,257

Economic Implications of Noxious Weeds

Spotted knapweed ranks as the number one weed problem on rangeland in Montana. It reduces livestock and big game forage, damages wildlife habitat and can double the amount of soil erosion from sites where it invades rangeland. Knapweed is estimated to cause an annual loss of forage valued at $4.5 million in Montana (French and Lacey 1983). Researchers in Montana estimate that 56% (33,924,000 acres) of the State's range and grazeable woodland (60,918,000 acres) is

susceptible to knapweed invasion. At the projected spread rate of 27% per year, all vulnerable land in Montana would be infested by knapweed in nine years if no effort is made to control its spread. Based on these estimates, the projected annual loss of revenue from grazing land in Montana could be $155.7 million (Bucher 1984). In addition to the projected loss to the livestock industry, a loss in wildlife habitat and big game animals can also be expected. Deer and elk are not known to use knapweed to any significant extent. A heavily infested knapweed stand should generally be considered out of production as big game range. An analysis of the effects of weeds on wildlife on the 2 million acre Lolo National Forest (Spoon et. al 1983) predicted that due to loss of forage from noxious weeds, an annual reduction of 220 elk per year could occur by 1988. It is estimated that hunters spend $1,800 per each harvested elk.

Knapweed impact is not limited to grazing land; forested areas and forest productivity is also affected. A 1% annual loss in timber productivity has been predicted on the Lolo National Forest (Spoon et. al 1983).

Leafy spurge is considered the most persistent noxious weed in North Dakota. It has a wide habitat suitability, prolific reproduction capabilities, strong competitive ability and is difficult to control. In North Dakota, loss of hay and beef cattle production is estimated at $7 million annually due both to reduced forage production from leafy spurge competition and to cattle avoiding leafy spurge infested areas (Lym and Messersmith 1985). Areas where leafy spurge comprises 20% or more of the plant community are completely avoided by livestock resulting in 100% reduction of carrying capacity for livestock (Lym and Messersmith 1985). Forage availability for wildlife is similarly limited.

Other weeds listed in Table I-1 produce somewhat similar effects on rangeland as the two species listed above. The economic impacts of these weeds are a direct correlation between loss of carrying capacity and acres infested.

CHAPTER IV
ENVIRONMENTAL CONSEQUENCES

IMPACTS ON AIR QUALITY

The impact on air quality from a weed treatment program would be the introduction of particulates and visible smoke from weed burning. Because of the research needs to answer questions concerning the effect of burning on certain noxious weeds, it is doubtful much burning would be accomplished in the short term and particulates and visible smoke would only slightly increase. Particulate emissions from weed burning would be highest under Alternative 5 (No Herbicide Use) and would not occur in Alternatives 1 (No Action), 3 and 6 (No Mechanical Treatments). Because weed burning would normally be done during periods of instability, the National Ambient Air Quality Standards (see Glossary) for particulate concentrations are not expected to be exceeded. Unforecasted weather changes could cause smoke to reach the Class I airsheds of the Northern Cheyenne Reservation in Montana and the Theodore Roosevelt National Park in western North Dakota and some population centers in or adjacent to the Forest. The probability of such an occurrence is extremely low because of the small acreage that would be burned and the distance most of the Forest is from population centers.

The air also serves as a carrier of spray drift. Liquid spray droplets most prone to drift are usually 100 microns or less in diameter and most spray equipment is designed to produce 200 micron droplets. The Forest's restriction on spraying to only low wind periods (10 mph or less) reduce the chance of airborne herbicides.

Although herbicide applications result in vapor losses, commercial uses have not shown volatility to lead to phytotoxicity (see Glossary) in non-target plants (NRCC 1974). Loss from volatilization is reported to be negligible with glyphosate (Weed Science Society of America 1983). Volatilization will depend on the formulation of 2,4-D, with acids and amines being less volatile than esters, which vary from high to low. Any esters used on the Custer National Forest would be of low volatibility. The oil soluble amines are considered to be least volatile. Dicamba may volatilize from soil surfaces but further study is required to determine the extent of such losses. Picloram volatilization is not considered a problem due to the low vapor pressure of the chemical. Herbicides could be moved out of the target area while adsorbed to dust particles carried by wind. Once in the air, spray droplets are subject to photodecomposition (see Glossary) by sunlight.

IMPACTS ON SOILS

Soils could be adversely affected by herbicide and mechanical noxious weed treatment. Removal of solid stands of noxious weeds by herbicide treatment might result in short-term insignificant increases in surface erosion that would be mitigated as vegetation reoccupies the treated site.

The behavior of a chemical substance in soil is determined by several properties relating both to the chemical and to the soil environment. The behavior in the soil environment of herbicides proposed for use is summarized in Table IV-1 and discussed below. Impacts on soils from herbicide applications would be greatest under Alternatives 2 and 6 and would occur also in Alternatives 3 and 4. It would be nonexistent under Alternatives 1 and 5.

TABLE IV-1
BEHAVIOR OF HERBICIDES IN SOILS

Active Ingredient/Common Name	Behavior in Soil
2,4-D	Degradability in soil depends on microbial activity but is fast in organic and moist soils. Persistence is short, and mobility is relatively high.
Dicamba/Banvel	Moderately persistent, does not adsorb readily to soil particles, and is highly mobile. Mainly lost from soil by microbial decomposition.
Glyphosate/Roundup, Rodeo	Strongly adsorbed by soil. Adsorption is higher with organic soils and lowest in sandy soils. Decomposes rapidly by microorganisms.
Picloram/Tordon	Highly stable in plants, can be leached, relatively nonvolatile. Moderately to highly persistent in soil. Relatively mobile.

The persistence of 2,4-D has been studied in a variety of soil types and under a wide range of environmental and laboratory conditions. Persistence of 2,4-D in most soils is short and is generally less than 1 month (Ashton 1982). Norris (1983) found the half-life of 2,4-D in soil to be 1 to 4 weeks with little potential for bioaccumulation. In general, 2,4-D is relatively mobile in soil compared with other herbicides (Ghassemi and others 1981). Microbial degradation is the major mechanism by which 2,4-D is lost from the soil, especially under warm moist conditions with high soil organic matter—conditions that stimulate the growth of microorganisms. 2,4-D is not thought to leach into streams (Norris 1981) because it is adsorbed to soil organic material and rapidly degraded by soil microorganisms. Only minor losses of 2,4-D activity occur due to photodecomposition and, for most formulations, due to volatilization.

Dicamba has a moderate (3 to 12 months) persistence in soil compared to other herbicides (Ashton 1982). Dicamba does not adsorb readily to soil particles and colloids and thus has a high degree of mobility in most soils. The major route for loss of dicamba in soil appears to be microbial degradation rather than chemical degradation or photodecomposition.

Glyphosate is completely and rapidly degraded in soil by microbial degradation. In soil, glyphosate resists chemical degradation, is stable to sunlight, is relatively nonleachable, has a low tendency to runoff, is strongly adsorbed to soil particles, has a negligible volatility, and only slightly affects soil microflora. Because of its strong adsorption to soil particles, glyphosate is relatively immobile in most soil environments.

The fate of picloram in soil is determined by several factors, including volatilization, photodecomposition, adsorption and leaching, runoff, and chemical and microbial degradation. Volatilization is not considered a major determinant of environmental fate because of the low vapor pressure of picloram. Picloram is degraded by natural sunlight and ultraviolet light, although the extent of photodecomposition under field conditions has not been measured. It is generally considered to be a mobile herbicide because its adsorption to soil particles is low. The mobility of picloram is less in soils high in organic matter. Preliminary studies with various soil types found that picloram is usually confined to the upper 1 foot of the soil profile when application rates are low (less than 1 pound/acre), but that it can readily move to depths greater than 3 feet, even in relatively dry areas, when the application rate is high (3 to 9 pounds/acre) (NRCC 1974).

Use of the four chemical herbicides as proposed under Alternatives 2, 3, 4, and 6 would not degrade soil productivity.

Alternatives 2, 4, and 5 would involve the burning of light noxious weed fuels that would not create the extremely high fire intensities that cause high losses of soil organic matter, the major source of nitrogen and sulphur in the soil. In addition to nitrogen and sulphur, nutrients, such as calcium, potassium, and phosphorous might be lost, resulting in short-term insignificant declines in soil productivity in the treated area. To offset this would be a short-term release of nitrogen from the burnt organic matter. Soil productivity could be slightly reduced by the destruction of some soil microorganisms, but impacts would be minor and short-lived because these alternatives would not involve the intense fires that reduce microorganisms most dramatically (Wells and others 1979). Short-term, slight increases in erosion could occur until vegetation reoccupies the treated area. Alternatives 1, 3, and 6 would not involve burning.

Mechanical weed control practices such as tilling could result in slight short-term increases in erosion. The erosion rates would quickly decline as desirable vegetation reoccupies the treated area. No impacts from mechanical treatment would occur under Alternatives 1, 3, and 6.

IMPACTS ON WATER RESOURCES

Impacts on Surface Water

The likelihood of a herbicide entering surface water depends upon the herbicide's persistence and mobility (see Glossary) and constraints on application. Small quantities of herbicides could enter streams through drift (see Impacts on Air Quality), but limiting spraying to wind conditions of 10 mph or less will minimize this. Some herbicides could also enter streams in surface runoff or through erosion of previously treated soils.

Where streamflow results from thunderstorms, surface runoff may flush herbicide residuals into streams in detectable levels. Amounts would depend on the length of time since spraying in which microbial action has been degrading the herbicide (see Impacts on Soils). The longer the interval, the less chance of residuals being present. The extreme care specified in the mitigation measures (see Chapter II, Alternatives, Including the Proposed Action) would eliminate nearly any significant impact to surface water. See Appendix G for individual chemical discussion.

Alternatives 2, 3, 4, and 6 would result in little herbicide reaching a stream because there would be strict adherence to the mitigation measures spelled out in Chapter II. Surface runoff would move less residual spray in Alternative 3 because less acreage would be involved and spray enter-

ing riparian zones could be better controlled. Thus, less residue would exist for movement into the streams. Alternatives 1 and 5 would result in no herbicides from Forest Service actions reaching the stream channel as none is proposed.

Herbicide applications would not affect suspended sediments, total dissolved solids, or water temperature. Other actions under Alternatives 2, 4, and 5, however, such as grazing, burning, and mowing could affect these conditions. Physical restrictions on tilling (such as steep slopes) would prevent significant impacts to water quality.

Grazing with sheep or goats to control selected weeds would produce little effect on overall water quality although trampling within the stream channels could degrade water quality. Water quality indicators such as coliform numbers would increase, and in shallow streams might exceed drinking water standards. These exceedance periods, however, would extend no longer than 24 hours after livestock removal.

Burning to control noxious weeds removes all top vegetation until the next growing season. This removal of vegetation cover would increase the potential of surface runoff and might increase suspended sediment and total dissolved solids levels in the streams until regrowth occurs. Rice and others (1972) found that the amount of sediment reaching streams is generally proportional to the amount of bare soil in a watershed. The size of the impact from a treatment would depend on amount of exposed soil, severity of the burn, and distance to the nearest stream.

Tilling for weed control on a small scale with streamside buffer strips can benefit water quality. The tilling action breaks the ground surface and allows a greater infiltration rate. Infiltration rates vary with soil types and slopes. But terrain restrictions and the scattered nature of weeds do not allow the widespread use of this technique. At the present time, tilling methods have not proved to be effective for the weed species found on the Custer National Forest.

Impacts on Ground Water

Since picloram, dicamba, and 2,4-D are relatively mobile herbicides, the potential exists for detectable traces to enter the ground water. The relative immobility of glyphosate prevents it from moving down into the soil profile (see Appendix G). The degradability of picloram, dicamba, and 2,4-D highly depends on microbes in the soil and water. The number of microbes decreases as herbicides percolate down through the profile. Ground water contains few if any microbes to carry on the degradation.

On the Beartooth District, the many soil microorganisms and high precipitation would combine to degrade or dilute herbicides to the level where little or no trace would occur in ground water. The Sheyenne District has moderate to high precipitation and sandy soils. Lower chemical rates than label recommendations would be used to limit the chance of occurrence of chemicals in ground water. On the remaining Districts of the Custer National Forest, little herbicide would enter the ground water for other reasons. Although moderate microbial levels slow the degradation process, low precipitation and deep ground water aquifers prevent herbicides from reaching ground water.

No herbicides previously applied to Custer National Forest lands have been reported to reach the ground water. Although little information exists, nonfederally applied herbicides on private land have been reported to enter the ground water.

Streams and wetlands are areas where the ground water often occurs close to the surface. These areas are also high in microorganisms. Because the amounts of herbicides are low and the microorganisms in these areas are high, no impacts on the ground water are expected.

In areas known to be sensitive to herbicide impacts, such as ground water recharge areas, further mitigation may be required or the proposed treatment may be dropped.

IMPACTS ON VEGETATION

Impacts on Terrestrial Vegetation

Terrestrial vegetation is the environmental component that would be most affected by the proposed weed treatment program. Treatment of noxious weeds could affect both target and nontarget vegetation.

Alternative 2 would have the greatest effect on noxious weeds (target vegetation) by providing the best possible total weed control effort. Alternatives 4 and 6 would have somewhat less impact than Alternative 2. Alternatives 3 and 5 would allow some restricted spread of noxious weeds while Alternative 1 would allow the unrestricted spread of noxious weeds.

The herbicides proposed for use, excepting glyphosate, are selective, affecting broadleaf plants but not grasses. Glyphosate is a broad spectrum, nonselective herbicide that affects most perennial plants, annual and biennial grasses, sedges, and broadleaf plants. Some chemical residue may be left for varying periods, depending upon soil and climatic conditions.

Because chemical drift could injure or kill nontarget vegetation, herbicides would not be app-

lied when weather conditions would defeat their effectiveness or when controlling the treatment would be difficult.

Appendix E presents the susceptibility of terrestrial vegetation to herbicidal active ingredients. Glyphosate, the least selective of the herbicides that could be used under Alternatives 2, 3, 4, and 6, would result in the greatest loss of nontarget vegetation. For the use of dicamba, picloram, and 2,4-D, broadleaf plants would be the main nontarget vegetation affected. Plants such as greasewood, snowberry, sagebrush, willow, aspen, and many forbs in or near treatment sites could be weakened or destroyed.

The extent of any nontarget vegetation loss would depend on the proximity of desirable species to treated weeds, method and rate of herbicide application, formulation of the herbicide, and herbicide used.

Most grasses resist applications of the proposed use rates of picloram, dicamba, and 2,4-D. Grasses become more abundant as plant competition is reduced after weed control is implemented.

The impacts of herbicides would be greatest under Alternatives 2 and 6 and less under Alternatives 3 and 4. Alternatives 1 and 5 would not apply herbicides.

Prescribed burning would suppress competing vegetation. Burning would promote regeneration of some grasses, forbs, and hardwoods but could destroy some non-sprouting shrubs and other trees. Some noxious weeds such as leafy spurge regenerate rapidly from their root system after a burn and compete with desirable species. The control of such species might thus require burning followed by applying low rates of herbicides. Impacts of burning would probably be greatest under Alternative 5 and progressively less under Alternatives 2 and 4. Alternatives 1, 3, and 6 would not permit burning.

Mowing would remove most above ground vegetation in treated areas and may damage or kill nontarget vegetation. Mowing would mainly decrease the amount of seed production of noxious weeds. Mowing would also weaken root and rhizome systems of creeping perennial weeds. Impacts of mowing would be greatest under Alternative 5, and progressively less under Alternatives 2 and 4. Alternatives 1, 3, and 6 would not involve mowing.

Tilling would injure top growth and the upper 12 inches of the underground systems of all vegetation within the treatment area. Depending upon the specific site, the moisture situation and the species (target or nontarget), this method tends to have limited effectiveness. Tilling can break up the rhizomes of noxious weeds that are creeping perennials, encouraging greater growth. It could also create a seedbed for other weed seed, thus promoting further spread. Reproduction of noxious weeds by seed can be greatly reduced by seeding the site with native or desirable vegetation species shortly after tilling. The extent and location of tilling activities would be limited by terrain and soil characteristics. Tilling would be the greatest under Alternative 5, and progressively less under Alternatives 2 and 4. Alternatives 1, 3, and 6 would not involve tilling.

Sheep and goats have been used to a small degree for leafy spurge control. They tended to only graze on certain species of leafy spurge and removed only the top growth. Since the greatest consumption of leafy spurge was about 50 percent, sheep and goats would also consume some nontarget species during the treatment period. Alternative 5 would have the greatest adverse impacts on nontarget species, and progressively less under Alternatives 2 and 4. No impacts would occur under Alternatives 1, 3, and 6.

There are only a few insects which are effective in controlling specific weeds (see Appendix F). No significant detrimental impacts to nontarget vegetation would result from the use of insects or pathogens under any alternative due to the state and Federal clearances needed before a release of these agents.

Impacts on Threatened and Endangered Plants

There are no known Federally listed threatened and endangered plants on the Custer National Forest. Unidentified populations of threatened and endangered plants could be susceptible to any impacts described for terrestrial vegetation. Direct effects of injury or death to plants could immediately eliminate a species in a portion of its range. The more subtle effects of vegetation community changes could eventually eliminate a species on a specific site locally through the loss of the ability to compete with other vegetation.

If the U.S. Fish and Wildlife Service determines that any vascular plant species is threatened or endangered, any action that would contribute to its extinction or to its threatened or endangered status would violate the Endangered Species Act of 1973, as amended. Therefore, a review will be made before any site-specific action to document any threatened or endangered plants known on the site and will identify measures to protect these species. If any are found, the proposed action will be modified, relocated, or abandoned as necessary to meet the requirements of the Threatened and Endangered Species Act.

There are many unique plants located on the Custer National Forest. A list of these can be found in

Appendix H. As part of the requirements common to all alternatives (see Chapter I, Purpose of and Need for Action), all alternatives would be responsive to areas containing unique plants and all activities will be managed to retain the habitat for these species.

IMPACTS ON ANIMALS

Impacts on Livestock

Impacts to livestock could occur directly from the ingestion of toxic noxious weeds and indirectly from changes in the current forage supply and exposure to herbicides. A study of knapweed has shown that infestation can drop forage production from 891 to 54 pounds per acre in a relatively short period (French and Lacey 1983). Toxic reactions occur to livestock that ingest poisonous weeds found on the Custer National Forest (Table IV-2). Leafy spurge, for example, contains an irritant to the eyes of cattle and horses. It also causes diarrhea in cattle which sometimes leads to death. Effects range from blisters to death within 30 minutes.

Chemical treatments are generally applied in a form or at such low rates that they do not affect livestock. Animals consuming forage treated with certain herbicides (picloram, 2,4-D, and dicamba) cannot be slaughtered for food within the period of time specified on the herbicide label. Dairy animals should not be grazed on areas treated with certain herbicides (picloram, 2,4-D, and dicamba) for the length of time specified on the label.

TABLE IV-2

IMPACTS OF TOXIC WEEDS ON FORAGING LIVESTOCK

Common Name	Scientific Name	Poison Symptoms	Causative Agent	Animals Affected
Leafy spurge	*Euphorbia esula*	Diarrhea, blisters in digestive tract, collapse and death.	euphorbon	all, but sheep graze on some biotypes without harming them.
St. Johnswort	*Hypericum perforatum*	Photosentization-blisters and scabs about eyes, mouth, ears, nose, and feet.	helianthrone (hypericin)	cattle, hogs, sheep, goats
Russian knapweed	*Centaurea repens*	Nervous disorders.		horses

[1] Symptoms may vary according to dose, duration, and plant growth stage at ingestion.
Sources: Hulbert and Oehme 1961; Muenscher 1961; Keeler and Tu 1983; Hawkes and others 1985.

Burning of weeds would temporarily reduce forage for livestock and in some cases could result in a denser weed regrowth than existed before burning. Combinations of burning, regrowth, and applying lower rates of herbicides could effectively control noxious weeds and allow forage grasses to regenerate more rapidly. Mechanical treatments may also reduce livestock forage during the treatment period.

Where sheep and goats are used for biological control, their performance may decline because of their having to eat less desirable vegetation when confined in particular areas. Other biological means (insects, microorganisms) would require that livestock not be allowed to use a pasture during relatively short periods. This would depend upon the biological agent used and guidelines for the establishment of the agent.

Alternatives 2, 3, 4, and 6 provide more desirable forage for livestock. The number of plants toxic to livestock or wild horses, such as leafy spurge, would decline. Alternative 1 would result in a decline in desirable forage. Alternative 5 would probably result in impacts similar to Alternative 1 since manual, mechanical, and biological methods with no use of herbicides are less effective and efficient in controlling noxious weeds.

Impacts on Wildlife and Fish

Impacts to birds and mammals would result primarily from the destruction of nontarget vegetation important to key habitats. Depending on the rate of application and formulation of herbicide, application would cause varying degrees of injury or losses of nontarget vegetation, thus decreas-

ing habitat for wildlife. These losses would be insignificant in the short term across the Forest because of the small areas treated (usually less than 60 acres in size and most often less than 10 acres). The effects of weed control would be significantly beneficial over the long term because weeds would be prevented from further degrading the habitat (National Academy of Sciences 1968, and Morris and Bedunah 1984).

The risks to the health of wildlife and fish from exposure to the herbicides 2,4-D and glyphosate are discussed at length in the Final Environmental Impact Statement on the Eradication of Cannabis on Federal Lands in the Continental United States at pages 4-20 to 4-41 (U.S. Department of Justice, Drug Enforcement Administration, July 1985). Specifically, the following two summaries of these impacts in that EIS are noted and quoted from the BLM FEIS Northwest Area Noxious Weed Control Program, page 46:

> Under routine circumstances, no animals are likely to receive highly toxic or fatal doses of any of the proposed herbicides. However, under unusual circumstances, if animals are directly sprayed and feed exclusively on vegetation containing herbicide residues, individual animals could receive acute toxic herbicide doses. It is also possible, although very unlikely, that under extreme case conditions, some individuals from some species could be severely affected by 2,4-D. However, even under those conditions, no species are likely to receive acute toxic doses of glyphosate. Therefore, no wildlife populations are likely to be adversely affected.
>
> Under routine case operations, no impact to slight impacts could occur to fisheries as a result of proposed herbicide use. In the extreme case, 2,4-D could cause individual aquatic species to be exposed to lethal concentrations for a short period of time and localized fish kill could occur.

The risk of wildlife and fish health effects from exposure to the herbicides dicamba and picloram would be less than that arising from the use of 2,4-D and glyphosate (USDI, FWS 1980).

Herbicide treatment is greatest in Alternative 6 and to a lesser degree in Alternatives 2, 3, and 4. Alternatives 1 (No Action) and 5 have no herbicide treatment.

A more thorough summary of impacts on wildlife and fish from exposure to 2,4-D and glyphosate can be found in Appendix C, incorporated from the BLM FEIS.

Prescribed burning could destroy animals, including birds, unable to flee the fire or escape into burrows. Spring burns (March through June) would destroy nests with eggs and young hidden in vegetation. Fall burns may temporarily displace some animals, but not threaten their lives.

Prescribed burning could also temporarily destroy wildlife habitat for some species until regrowth of wildlife habitat occurs. Effects on ground cover would vary with burn intensity. Lower intensity burns on wet sites would remove less ground cover than higher intensity burns on dry sites. Loss of small ground cover and charring of larger branches and logs in small areas of tree cover (with trees exceeding 3 inches in diameter) would harm some birds (woodpeckers, chickadees) and small mammals (weasels, rabbits, deer mice) that use these riparian area residues for food or shelter. Charring of large branches and logs would also harm insects, an important link in the food chain. These impacts from burning are usually short-term, whereas in the long term wildlife could benefit from increased forage production in important areas. Burning of downed woody materials could cause a long-term reduction of this important habitat in riparian areas. Prescribed burning is greatest in Alternative 5, and would occur as part of an integrated program in Alternatives 2 and 4. No prescribed burning would occur in Alternatives 1 (No Action), 3, and 6.

Mechanical treatments could displace large animals for the time of the project and could have indirect effects associated with damaged target and nontarget vegetation.

Biological controls involving the use of sheep or goats would probably displace some big game species during the treatment period and might cause some temporary loss of feed for the treatment year. Other biological methods (insects, microorganisms) should not adversely affect wildlife. Biological control methods would not significantly affect aquatic plants or animals.

Mechanical and biological treatment impacts would be the greatest in Alternative 5, although these are considered to be insignificant. No impacts would occur in Alternatives 1 (No Action), 3, and 6.

Impacts on Threatened and Endangered Animals

Threatened and endangered species receive special attention under the Endangered Species Act of 1973, as amended, and Forest Service policies and guidelines. Noxious weed control activities will avoid known nest and roost sites and critical habitat of listed species or will take special precautions to ensure the well-being of these species. No adverse impacts are expected to occur on existing sites.

IMPACTS ON CULTURAL RESOURCES

Mechanical and burning control measures could potentially disturb or destroy unidentified cultural resources on or near the ground surface. The potential for damage would vary with the amount of ground disturbance and burning under each alternative. Tilling weeds could damage artifacts and disrupt relative positions of cultural materials. Mixing organic matter in archeological sites could contaminate carbon 14 dating samples, making them unreliable for scientific analysis. Uncovering sites could increase the possibility of illegal artifact collecting. Burning for weed control could destroy combustible cultural materials and damage stone and ceramic artifacts. The circumstance may occur, however, that burning could aid in the discovery and recovery of significant cultural resources, as seen at the cultural inventory following a wildfire at Custer Battlefield, Crow Agency, Montana, 1983.

Cultural resource surveys would precede management actions that could damage cultural resources. Sites discovered during these surveys will be protected in accordance with appropriate Federal regulations (36 CFR 800).

IMPACTS ON VISUAL RESOURCES AND RECREATION

Treatments such as tilling, burning, and applying herbicides cause visual impacts mainly by creating color contrasts between treated areas and surrounding vegetation. Tilling disrupts the land surface and exposes bare soils to view. In addition to causing color contrasts, applying herbicides reduces vegetation variety and can prevent the occurrence of seasonal changes (spring flower, fall color) within treated areas. Burning creates contrasting blackened areas and releases smoke, which temporarily impairs visibility. These short-term impacts, however, would end with the reestablishment of other plants on the sites.

The Visual Quality Objectives (VQO) are established by the Visual Management System (USDA Handbook 462) for each specific project. These VQO's identify the acceptable level of alteration to the landscape. Herbicide and biocontrol methods would not create any changes in the landscape that would exceed these limits. Mechanical methods would create some degree of unacceptable impacts, but usually on a short-term basis. Alternatives 1 and 5 would create little detrimental visual impacts. Some short-term effects would be expected in Alternatives 3 and 6. Alternatives 2 and 4 would likely create some reoccurring negative impacts until infestations were eliminated.

Impacts of herbicide residue on the health of public land visitors are discussed in Impacts on Human Health.

Developed recreation sites or areas of concentrated use identified as priority areas would be treated in Alternatives 2, 4, and 6. Alternatives 1, 3 (no priority areas), and 5 (lack of large infestation) would not treat these areas and the spread of noxious weeds would likely be encouraged by the translocation of seed, pollen, and burrs. The recreation experience level in recreation sites in this alternative would be decreased with the weed infestations as the stickers of thistle, irritating latex of leafy spurge, and the poisons of other noxious weeds create threatening situations for adults, children, and animals.

IMPACTS ON WILDERNESS AND SPECIAL AREAS

The threat of spreading exotic noxious weeds through the Absaroka-Beartooth is a serious one. During the 1985 field season, one-half acre of spotted knapweed was inventoried. Wilderness character can be affected by the spread of noxious weeds and could pass unnoticed by an untrained eye until infestations were widespread. The successful competition of these plants would eventually decrease the diversity and vigor of the natural occurring vegetation.

As more visitors and recreation livestock travel through the wilderness, the chances of spread increase. Forest Service policy (FSM 2323.24b) allows chemical or hand-grubbing control for noxious weeds. Such a program would require Regional Forester approval (2323.04b). None of the alternatives proposes a treatment program for the Absaroka-Beartooth. A site-specific analysis would be prepared for the Regional Forester's approval tiered to this Environmental Impact Statement, if and when such a program is proposed.

The Red Lodge Municipal Watershed (Beartooth Ranger District) is an area of special consideration. Before any treatment is proposed, further environmental analysis and public involvement would be completed. The analysis would be tiered to this Environmental Impact Statement.

IMPACTS ON ECONOMIC AND SOCIAL CONDITIONS

The economic and social effects of spreading noxious weeds is often difficult as the costs are often hidden and the effects tend to be cumulative.

Based on current range carrying capacities estimated for livestock on the Custer National Forest

(3.5 acres per animal unit month), the present acreage of noxious weeds has displaced about 2,500 AUMs. These losses are reflected in reductions of revenues to the Federal government, as well as a more local loss to the agricultural and livestock industries. The Forest influence is primarily on the livestock industry and the cost of this loss can be estimated.

The Forest rangelands usually offer an 8-month season of use, and by assuming a loss of 2,500 AUMs (noted above), it can be determined that equates to 312 cow/calf pairs. With the assumption of a 400 pound calf at market time and given the 1986 current price of 65 cents per pound, the cost to the industry would equal $81,120 annually. This also assumes that the level of noxious weeds will remain constant.

Another potential economic impact is the spread of noxious weeds from the Forest lands to adjacent private and other Federal land ownerships. The cost and potential effect of this spread is not known.

The appropriated funded program on the Custer National Forest in 1985 was $83,000, in which a total of 1,292 acres were treated. (Other additional acreages, 3,120 acres, were treated with Conservation Practices (CP) funds). The present program level is not keeping up to the current rate of spread. Therefore, the losses will continue to increase annually as well as continue to threaten adjacent lands.

The population in and adjacent to the Custer National Forest is predominantly rural, 50.6% rural residences. The counties within the Forest average 93.6% rural residences. (Rural residence is considered to be the individuals living outside communities of less than 2,500 inhabitants and includes those persons living in rural portions of extended cities.) Of the 20 counties within Forest lands, only three have urban classified areas; that being Park County, Montana, with 55.2% urban, Rosebud County, Montana, 25.8%, and Richland County, North Dakota with 47.2%. The business patterns in these 20 counties is agricultural oriented. The economic effects of spreading noxious weed infestations could have severe impacts on the livelihood of these counties' residents. Under current economic conditions of decreasing land values and decreasing livestock market values, rural areas such as these are being economically threatened. The impacts of noxious weed infestations on the private land is an additional hardship, let alone the decrease in the productivity of Federal lands. This decrease of goods and services from the natural environment causes a significant impact on the area's economic well-being, and the economic stability of these areas becomes somewhat strained. This is evident throughout the country as people move from a rural-agricultural setting to urban communities which offer greater economic stability.

IMPACTS ON HUMAN HEALTH

Mechanical Treatments

Smoke from burning is not expected to significantly affect human health under any alternative. Levels of suspended particulates (a suspected factor in some health problems) are expected to be well below the 150 micrograms per cubic meter (ug/m^3) public welfare standard and the 260 ug/m^3 public health standard published by EPA.

Workers on burn areas would be exposed to potential injury from the manual treatments they would apply and the conditions under which they would work (see discussion under Manual and Mechanical Treatments below). Workers who manually ignite burn areas would be exposed to burning materials, which could cause physical injuries.

The probability of workers on burn areas being injured would be about the same under Alternatives 2 and 4, but would increase under Alternative 5. Alternatives 1, 3, and 6 would not permit burning.

Public safety would not be affected by any method of igniting burn areas. Most burning would occur where the public either would not be present or would be highly visible to those doing the burning. Further, those on or near a burning area would be well aware of impending activities because several hours of active preparation are required before ignition begins. Safety measures normally taken to protect firefighters participating in prescribed burning would also protect the public.

Operators of machinery (such as tractor-mounted mowers) could be injured by losing control of equipment on steep terrain or by coming into contact with flying debris and brush. Such hazards would be most likely under Alternatives 2, 4, and 5 and would not occur under Alternatives 1, 3, and 6.

Manual Treatments

Under Alternatives 2, 4, and 5, some hand pulling could be done, and this would expose workers to the hazards of physical contact with irritant weeds that cause blisters, inflammation, and dermatitis (leafy spurge, *Euphorbia esula*). Sensitive individuals can react severely to the pollen of various weed species, and the close contact of hand pulling could cause major discomfort or health risk. A severe hazard of hand pulling is the high potential for poisonous snake bite. The

remoteness of many treatment areas and the time needed to gain medical attention would complicate some cases of snake bite poisoning.

Chemical Treatments

Because herbicides are intended to be toxic to plants, they are designed to interfere with these vital plant processes that do not occur in animals: seed germination, hormone (auxin)-mediated growth and development, and photosynthesis. Basic biological and physiological differences between plants and animals partly account for the relatively low toxicity of herbicides to animals.

An extensive analysis of herbicides proposed for use in Region 1 has been documented in "Analysis of Human Health Risks of USDA Forest Service Use of Herbicides to Control Noxious Weeds in the Northern Region". This document provides the basis to analyze the human risk associated with the noxious weeds program on lands administered by the Custer National Forest.

The human risk analysis (Appendix B) assesses exposures at levels which are higher than would be anticipated under the proposed application rates. In addition, mixing errors and a variety of incidents are considered which would be unlikely, yet possible occurrences in a spray situation. All cases also consider large spray areas which are of a magnitude greater than most projects on the Forest. Even when considering worst case situations, the no observable effect levels (NOEL) are not exceeded. The worker dose levels do not exceed NOEL's but ADI's are exceeded in all situations. This considers the worst case and emphasizes the importance of a well controlled program which provides maximum protection to minimize exposure.

See Appendix B for the complete health risk analysis for the Custer National Forest. The following discussion is a summary of that appendix.

The herbicides considered for use on the Custer National Forest are glyphosate, 2,4-D, picloram, and dicamba. Alternatives 2, 3, 4, and 6 would use all of these chemicals. The proposed range of application rates common to these alternatives can be found in Appendix B and do not exceed tolerable limits of human health risk. The rate of application would not vary among these alternatives. The differing factors are the strategies and acres treated in the alternatives.

The main impacts on human health from herbicide treatments depend upon the toxicity of the chemical and the level of human exposure. All chemical effects on biological systems follow a dose-response relationship; as dose increases so does effect, and vice versa. The chemicals proposed for use on the Custer National Forest have not been found to cause significant mutagenic or carcinogenic effects. For such chemicals, a no observed effect level (NOEL) dose can be established as the highest dose that causes no toxicologic change in exposed animals. The term threshold is also used to identify this dose range. These NOEL's have been determined for application rates of 1 lb AI/A for picloram, dicamba and glyphosate, and 2 lbs AI/A for 2,4-D. The 2,4-D/picloram mix is assumed to be applied at 1 lb AI/.25 AI/A. It is important to note that these levels either equal or are in excess of proposed application rates for the Custer National Forest (see Appendix B). NOEL is the highest daily dose that causes no effect in the animal test population. Table IV-3 shows the relative NOEL values for the herbicides proposed for use in this EIS.

TABLE IV-3

TOXICITY OF PROPOSED HERBICIDES

Herbicide	Toxicity	Teratogency	Carcinogenicity	Chronic Toxicity NOEL in mg/kg/day
2,4-D	mildly toxic	potentially	potentially	1.00
Dicamba	slightly toxic	potentially	no evidence	1.25
Glyphosate	slightly toxic	none observed	potentially	10.00
Picloram	slightly toxic	none observed	potentially	7.00

Dicamba is generally nontoxic to a wide variety of nontarget organisms. Studies with invertebrates and microorganisms show, in general, median lethal concentrations in excess of 100 ppm. It is only slightly toxic in fish and amphibians with LC_{50}'s in excess of 10 ppm. Acute oral toxicities in birds were equal to or greater than 673 mg/kg body weight.

In experimental studies with mammals, dicamba was a mild skin irritant and moderate skin sensitizer. Direct application of dicamba caused transient low grade eye irritation. The inhalation toxicity of dicamba was very low. Acute and subchronic ingestion of dicamba in laboratory animals resulted in slight toxicity. In isolated case

reports, oral ingestion of dicamba by sheep caused death. Chronic consumption of dicamba in the diet by rats and dogs for two years elicited no adverse health effects, but chronic consumption by mice caused decreased body weight and increased liver weight. In rats, dicamba caused no reproductive or teratogenic effects. In rabbits, dicamba caused post-implantation losses, a decreased number of live fetuses, and decreased fetal weights. Dicamba is not considered to be mutagenic.

Picloram and its salts are low in toxicity to most nontarget organisms. Picloram is relatively nontoxic to soil microorganisms at concentrations up to 1,000 ppm. For most species of fish, picloram formulations are only slightly toxic with median lethal concentrations of greater than 10 ppm. The acute toxicity for birds is greater than 2,000 mg/kg. In subchronic feeding studies, with birds, the LC_{50} is greater than 5,000 ppm.

In studies with experimental and farm animals, the acute toxicity ranged from 8,200 mg/kg in rats to greater than 950 mg/kg in cattle. Tests with rabbits indicate that picloram is not likely to be absorbed through the skin. The LD_{50} in dermal toxicity tests with rabbits is greater than 4,000 mg/kg. Although it is a mild skin irritant in rabbits, patch tests show that it does not sensitize the skin of humans. Rats, exposed to a saturated atmosphere of picloram formulation for 7 hours, showed no significant adverse effects indicating that inhalation of picloram is not likely to cause illness. Since picloram induces only moderate eye irritation in rabbits, which heals readily, it is not likely to cause injury to the cornea or blindness. Long-term studies in rats and dogs showed no observable adverse effects when doses of up to 150 mg picloram/kg body weight were fed for 2 years. Studies in rats and mice showed that picloram is nonteratogenic even at doses toxic to the pregnant animals, and has little or no effect on fertility, reproduction, or development of offspring. Picloram was generally found to be nonmutagenic and noncytogenetic. It appears to present little or no carcinogenic risk, although bioassays on mice and rats suggested the ability to induce benign liver tumors in rats.

Glyphosate is generally nontoxic to a variety of invertebrate organisms. The formulation, Roundup, is toxic to some species due to the presence of toxic surfactants. The susceptibility of invertebrates and microorganisms to glyphosate toxicity exists over a broad range, with some species exhibiting effects at 3 ppm glyphosate and other species showing no effects at greater than 200 ppm. Studies conducted with various species of rainbow trout, bluegills, and other species of fish showed that these species were extremely tolerant to glyphosate. It has a low toxicity to birds.

The relatively low toxicity of glyphosate is reflected in acute oral LD_{50} values greater than 3,800 in mammals. Tests in rabbits indicate that the herbicide is not likely to pose a hazard by absorption through the skin. Patch tests of formulated project on human skin revealed no evidence of injury or sensitization to the herbicide. Tests in rabbits showed that Roundup or glyphosate were only slightly irritating to the eyes. The irritation was completely reversible and no injury to the cornea was observed, indicating that with ordinary precautions glyphosate is not likely to cause injury to the eyes or cause blindness. Roundup was only "slightly toxic", with an LC_{50} of 3.28 ppm when rats were exposed to an aerosol for 4 hours.

In subchronic 90-day oral studies, rats and dogs were fed glyphosate at concentrations of up to 2,000 ppm in the diet without any adverse effects. In chronic studies, rats and dogs were fed glyphosate in their diets at rates up to 300 ppm for 2 years, and mice were fed similar concentrations of glyphosate for 18 months. Except for some slight changes in the liver of rats (NOEL was 30 mg/kg/day), no significant treatment related abnormalities were observed. There was no evidence of carcinogenicity in studies with rats and dogs. Studies in rats and rabbits showed that glyphosate is not teratogenic. There were no reproductive effects in rats when tested in multigeneration reproduction studies. Glyphosate was not mutagenic when tested in a dominant lethal mutation assay in mice or in a number of microbial mutagenicity tests employing bacteria or yeasts.

In the alternatives proposing herbicide application (2, 3, 4, and 6), the tolerable limit of health risk are not exceeded and in most cases are substantially below. Because Alternative 2 is an all-out treatment program including herbicides and Alternative 6 is a more limited program using only herbicides, they are considered to represent the greatest potential for error, accident, and risk. Alternatives 3 and 4 present less of this potential. Alternative 1 (No Action) and Alternative 5 would not allow any herbicide applications.

Chemical exposure may be brief (acute) or prolonged (chronic). The kind of response (acute or chronic) observed in organisms depends on the route of intake (oral, dermal, inhalation) and frequency of exposure, coupled with the specific mechanisms of toxicity. A chemical of high toxicity may represent no or limited hazard if exposure and dose are low, just as a chemical of limited toxicity may be hazardous if exposure is high.

Extensive studies of the absorption, distribution, metabolism, and excretion of herbicides in animals (DOE, BPA 1983) have shown that the herbicides and their metabolites are rapidly eliminated from most animals and do not substantially

accumulate in animal tissues. These traits further reduce the possibility that exposure will result in harmful consequences.

Of concern is the probability that use of a chemical will result in an irreversible disease such as reproductive or genetic effects. Reproductive effects include infertility, miscarriage, general fetal toxicity, and birth defects (teratogenesis). Genetic effects are those that alter cellular DNA and could result in cancer or mutations. Almost all chemicals will produce reproductive effects in the laboratory at some dose, although some cause maternal death before any detectable impact on the fetus. Of the great number of chemicals in commerce that have been tested, few have been shown to cause cancer, and few have shown significant mutagenic activity in the variety of tests used to screen for genetic activity.

All workers must be advised explicitly of the hazards of these chemicals and instructed in the careful herbicide application techniques so as to reduce dose levels below worst-case values assumed here. Several studies have shown that work practices greatly affect worker exposure and dose.

For some herbicides, such as 2,4-D and dicamba, restrictions on the amount of herbicide applied daily may be necessary for workers subject to higher exposure (e.g., backpack sprayers). Alternatively, application methods resulting in lower exposure to workers may be used. For example, use of trucks or tractors equipped with boom sprayers could be used in some areas. For workers in high-exposure occupations, such as backpack sprayers, application days should be limited to 30 days in a year for 2,4-D or dicamba.

Restrictions on the use of women as applicators are advisable for some herbicides. For example, because of the low teratogenicity margins of safety for workers spraying dicamba, restrictions on the use of women of child-bearing age as herbicide applicators may be necessary. These restrictions should be made on a site-specific basis depending on the projected worst-case worker dose and the toxicity data of the herbicide.

The above discussion on herbicide treatments was taken from the following sources: Final Environmental Impact Statement, Northwest Area Noxious Weed Control Program, U.S. Department of the Interior, Bureau of Land Management, Portland, Oregon, December 1985; U.S. Department of Agriculture, Forest Service, Region 1, Human Risk Analysis; and USDA, Forest Service, Pesticide Background Statement, Volume I, Herbicides, Agriculture Handbook No. 633, August 1984.

SYNERGISTIC EFFECTS

Synergistic effects of herbicides are those that occur because of simultaneous exposure to more than one herbicide and that cannot be predicted based on the effects of the individual chemicals.

Kocida and Mullison (1985) use a specific example of a mixture of 2,4-D and picloram to illustrate that the LD_{50} of each herbicide separately and the LD_{50} of the mixture do not demonstrate synergism since the LD_{50} of the mixture is between the LD_{50} of the two constituents. Therefore, synergism is not expected to occur in this program (see Appendix C).

CHAPTER V
LIST OF PREPARERS

EIS Team Members

Susan M. Zike Koch
EIS Team Leader, Forest Landscape Architect and Planning Team Member — B.S. Landscape Architecture, Iowa State University, 1974; 10 years Forest Service experience; primary responsibilities in land management planning, recreation and visual resources.

William A. Fortune
EIS Team Member, Sheyenne District Ranger — B.S. Range Management, Montana State University, 1969; 15 years Forest Service experience: 2 years District Ranger, 5 years supervisory range conservationist, 2 years resource assistant, and 6 years range conservationist; primary responsibilities in range, wildlife, watershed and lands.

Charles E. McGlothlin
EIS Team Member, Forest Range, Wildlife and Watershed Staff Officer (Retired 1986) — B.S. Range Management, Montana State University, 1960; 25 years Forest Service experience: 6 years Range, Watershed and Wildlife Staff Officer, 8 years District Ranger, 3 years supervisory forester and 8 years range conservationist; primary responsibilities in range, wildlife, and watershed.

Brent Handley
EIS Team: Member, Supervisory Ranger Conservationist, Medora Ranger District — B.S. Range Conservation, New Mexico State University, 1979; 5 years Forest Service experience: 2 years range conservationist and 3 years supervisory range conservationist; primary duties in range, noxious weed treatment and health risk analysis.

Mark Petroni
EIS Team Member, Range Conservationist, Ashland Ranger District —B.S. Forestry, University of Montana, 1976; 9 years Forest Service experience; primary responsibilities in timber, range, wildlife, fire and watershed.

Resource Support Specialists

John M. Edwards
Forest Wildlife Biologist — B.S. Wildlife Biology, M.S. Fish and Wildlife Management, Montana State University 1974, 1977; 8 years Forest Service experience; primary responsibilities in land management 'planning and wildlife.

Lee McConnell
Forest Soil Scientist and Watershed Specialist — B.S. Forest Management, M.S. Forest Soils, Univeristy of Idaho, 1963, 1967; 13 years Forest Service experience; primary responsibilities as Soils Scientist in timber sale preparation, soil and land type inventory, woodland conservation, soil conservation and soil-watershed specialist.

Kathy E. Ives
Printing and Word Processing Techinician — Billings West High School, 1973; 10 years Bureau of Land Management experience; primary responsibilities in word processing and printing.

Kenneth Gehman
Forest Illustrator — B.A. York Academy of Art, Pennsylvania; 9 years Forest Service experience; primary responsibilities in illustration, graphics and layout.

Consultation with Others

Rene'-Marc Mangin
Integrated Pest Management Specialist, Northern Region, USDA Forest Service

Mike McNeil
Range Conservationist, Custer National Forest, USDA Forest Service

Robert Carlson
Department of Entomology, North Dakota State University, Fargo, North Dakota

Robert Hofstra
Department of Entomology, North Dakota State University, Fargo, North Dakota

Celestine Lacey
Weed Coordinator, Montana Department of Agriculture, Helena, Montana

Jim E. Nelson
Extension Weed Specialist, Montana State University, Bozeman, Montana

John Lacey
Extension Range Specialist, Montana State University, Bozeman, Montana

Norman Rees
Research Entomologist, USDA Agricultural Research Service, Rangeland Insect Lab, Montana State University, Bozeman, Montana

CHAPTER VI

LIST OF AGENCIES, ORGANIZATIONS, AND ELECTED OFFICIALS TO WHOM COPIES ARE SENT

ELECTED OFFICIALS

Montana

Max Baucus, U.S. Senator
John Melcher, U.S. Senator
Ron Marlenee, U.S. Congressman
Carroll Graham, State Senator
S.A. Olson, State Senator
Marion Manning, State Congressman
Ted Schwinden, Governor of Montana
Robert Wilson, District Judge
Montana County Commissioners
- Carbon County
- Carter County
- Park County
- Powder River County
- Rosebud County
- Stillwater County
- Sweetgrass County

North Dakota

Quentin Burdick, U.S. Senator
Mark Andrews, U.S. Senator
Byron Dorgan, U.S. Congressman
George Sinner, Governor of North Dakota
North Dakota County Commissioners
- Billings County
- Bowman County
- Dunn County
- Golden Valley County
- Grant County
- McHenry County
- McKenzie County
- Ransom County
- Richland County
- Sioux County
- Slope County

South Dakota

James Abdnor, U.S. Senator
Larry Pressler, U.S. Senator
Thomas Daschle, U.S. Congressman
N.F. Lyon, State Congressman
G.F. Mortimer, State Congressman
Robert Samuelson, State Senator
William Janklow, Governor of South Dakota
South Dakota County Commissioners
- Corson County
- Harding County
- Perkins County
- Ziebach County

FEDERAL AGENCIES

Agriculture Research Service
Animal and Plant Health Inspection Service
ASCS Office
Bureau of Indian Affairs
Bureau of Land Management
Bureau of Reclamation
Cooperative Extension Service
Environmental Protection Agency
Farmers Home Administration
Fish Control Laboratory
Fish and Wildlife Service
Forest Service
- Northern Regional Office
- Rocky Mountain Research Station
- Rocky Mountain Range & Forest Experiment Station
- Helena National Forest
- Gallatin National Forest
- Nebraska National Forest
- Shoshone National Forest
- Bighorn National Forest

National Park Service
- Theodore Roosevelt National Park
- Yellowstone National Park

Northern Great Plains Research Center
Soil Conservation Service

STATE AGENCIES

Montana

Department of Community Affairs
Department of Fish, Wildlife and Parks
Department of Health
Department of Natural Resources & Conservation
Department of State Highways
Department of State Lands
Governor's Office
State Clearinghouse
State Historic Preservation Officer
State Library

North Dakota

Association of Soil Conservation Districts
Department of Agriculture
Department of Health
Division of Planning
Environmental Review Coordinator
Game and Fish Department
Governor's Office

Highway Department
Natural Heritage Program
North Dakota Forest Service
Soil Conservation Committee
State Water Commission

South Dakota

Commissioner of Schools and Public Lands
Department of Game, Fish and Parks
Department of Water and Natural Resources
Governor's Office
State Clearinghouse
State Historic Preservation Office
State Planning Bureau

ORGANIZATIONS, ASSOCIATIONS, CLUBS, ETC.

Absaroka-Beartooth Outfitters
American Fisheries Society
American Wilderness Alliances
Association of National Grasslands
Badlands Environmental Association
Billings Lion Camp
Billings Lion Club
Birney Land Protective Association
Bridger Lions Club
Cross Creek Protective Association
Defenders of Wildlife
Ducks Unlimited
Harding Co. Stockgrowers Association
Horse Creek Cooperative Grazing Association
Inland Forest Resource Council
Little Missouri Grazing Association
McKenzie County Grazing Association
Medora Grazing Association
Montana Audubon Council
Montana Stockgrowers Association
Montana Water Development Association
Montana Wilderness Association
Montana Wilderness Society
Montana Wildlife Federation
Montana Woolgrowers Association
National Audubon Society
National Forest Products Association
Nature Conservancy of North Dakota
North Dakota Chapter of the Wildlife Society
North Dakota Natural Science Society
North Dakota Stockmen's Association
Northern Plains Resource Council
Production Credit Association
Ransom County Drainboard
Richland County Drain Board
Rocky Mountain Oil and Gas Association
Sheyenne 4-H Camp Association
Sheyenne Valley Grazing Association
Sheyenne Valley Association
Sierra Club
Society of American Foresters
Society of Range Management
Stillwater Protective Association
Western Environmental Trade Association
Western Wood Products Association
Wilderness Society
Wildlife Management Institute
Wyoming Environmental Institute
Yellowstone Bighorn Research Association
Yellowstone Valley Audubon Society

APPENDIX A
WEEDS CONSIDERED NOXIOUS BY STATE

Name of Weed					Likely to be Found on or Near the Forest	
Common	Scientific	Montana	North Dakota	South Dakota	Yes	No
Absinth Wormwood	*Artemisia absinthium*		X		X	
Canada Thistle	*Cirsium arvense*	X	X	X	X	
Field Bindweed	*Convolvulus arvensis*	X	X	X	X	
Hemp (Marijuana)	*Cannabis sativa*		X		X	
Hoary Cress (whitetop)	*Cardaria draba*	X	X	X	X	
Leafy Spurge	*Euphorbia esula*	X	X	X	X	
Musk Thistle	*Carduus nutans*		X	X	X	
Perennial Sow Thistle	*Sonchus arvensis*		X	X	X	
Russian Knapweed	*Centaurea repens*	X	X	X	X	
Spotted Knapweed	*Centaurea maculosa*	proposed	X	X	X	
Diffuse Knapweed	*Centaurea diffusa*	proposed			X	
Dalmation Toadflax	*Linaria dalmatica*	X			X	
Saint Johnswort	*Hypericum perforatum*	X			X	
Dyers Woad	*Isatis tinctoria*	X				X
Yellow Star Thistle	*Centaurea solstitialis*	X				X
Common Curpina	*Curpina vulgaris*	X				X
Tansy Ragwort	*Senecio jacobaea*	X				X
Rush Skeletonweed	*Chordrilla juncea*	X				X

This is a list of noxious weeds taken from state laws or regulations. Additional weeds may have been declared by the Boards of County Commissioners in the various districts.

APPENDIX B
HUMAN HEALTH RISK ANALYSIS

The purpose of this Health Risk Analysis is to ascertain the worst-case scenario that is reasonably within the scope of the proposed herbicide treatments on the Custer National Forest. Although there are differences across the Forest, reasonable grouping of projects and treatment can be made by grouping similar vegetative settings and herbicide treatments. The following discussion is taken primarily from Appendix I, Proposed Treatment Program on the Custer National Forest, and indicates the range of application rates that are analyzed for human health risk. The Health Risk Analysis is based on a worst-case scenario as taken from the Northern Region Health Risk Analysis (Appendix J). Any project with factors that represent less risk are considered to be within (or below) the worst-case analysis framework.

Type 1 Project:

This project typifies the majority of the treatment projects on the Custer National Forest. It is classified in Appendix I as grasslands vegetative setting. Noxious weeds typically encountered in this setting are leafy spurge, absinth wormwood, Canada thistle, spotted knapweed, Russian knapweed, and St. Johnswort. These infestations can range from very dispersed, spotty inclusions to moderately dense areas. Herbicide treatment is by vehicle-mounted or tractor-pulled sprayers with booms for the larger areas, hand-held pressure nozzles, or broadcast bead (granular). This project, at a maximum, would cover 80 acres in one day for mounted boom sprayers and 3.3 acres in one day by one person with a hand-held spray unit. This is known to have occurred only once in the history of the Forest's weed treatment program, when weather conditions held throughout the day and equipment functioned without failure. This is believed to be a maximum; a more typical acreage for one worker in one day is 24. This setting is classified in the Health Risk Analysis as the "Large, Open Range Project." Tables B-4a, 5a, 5b, 6a, 7a, and 7b assume maximum application rates and disclose the Human Health Risk Analysis for various herbicide treatments.

Application rates for the various possible herbicides are shown below:

Herbicide	Range of application rates used on the Forest
2,4-D only	.5 lb AI/A to 2 lbs AI/A
Picloram	.25 lb AI/A to 1 lb AI/A
2,4-D/Picloram mix	1 lb AI/.125 lb AI/A to 2 lbs AI/.5 lb AI/A
Glyphosate	1 lb AI/A

All of these rates fall within the Custer's Health Risk Analysis (discussed later in this Appendix) for the worst-case exposure and are considered to be within tolerable risk on the Custer National Forest and the Northern Region of the Forest Service.

Type 2 Project:

This project occurs in what is commonly referred to as woody draws or hardwood draws. On the Sheyenne Ranger District, it will include the oak savanna. Open water is not associated with this setting, but water tables are significantly closer to the surface in these areas than in the typical grasslands setting. The noxious weeds encountered in this vegetative setting are usually leafy spurge, spotted knapweed, and Canada thistle. Infestations are generally less dense than those in the grassland setting, although some draws are known to be thoroughly infested. These weeds are usually intermixed with understory shrubs such as snowberry or chokecherry which complicate herbicide treatments. Application methods in this setting are much more controlled than in the grasslands and accomplished by hand-held pressure nozzles from a vehicle-mounted or 4-wheeler-mounted tank, backpack sprayer, controlled droplet applicators, or hand-held broadcasters. This project, at a maximum, would cover 80 acres in one day with a mounted boom sprayer and 3.3 acres in one day by one person with a hand-held spray unit. This is a maximum estimate and in most situations would be significantly less. This setting is classified in the Health Risk Analysis as the "Large, Open Range Project." Tables B-4a, 5a, 5b, 6a, 7a, and 7b assume maximum application rates and analyze the health risk of this type of treatment.

Herbicide	Range of application rates used on the Forest
2,4-D only	.5 lb AI/A to 2 lbs AI/A
Picloram	.25 lb AI/A
2,4-D/Picloram mix	1 lb AI/.25 lb AI/A to 2 lbs AI/.5 lb AI/A
Glyphosate	.75 lb AI/A to 1 lb AI/A

All of these rates fall within the Custer's Health Risk Analysis (discussed later in this Appendix) for the worst-case exposure and are considered to be within tolerable risk on the Custer National Forest and the Northern Region of the Forest Service.

Type 3 Project:

This project treats noxious weed infestations in forested areas. Currently this situation occurs only on the Ashland and Beartooth Ranger Districts and is usually associated with road rights-of-way. The noxious weeds encountered in this vegetative setting are leafy spurge, spotted knapweed, and Canada thistle. The infestations are usually clustered along the road edges and are closely associated wtih the riparian setting, although application methods differ. Application methods are all hand-held, usually from back-pack sprayer or vehicle or 4-wheeler mounted sprayers with boom sprayers. Because of the spotty linear nature of the infestations and the distances between infestations on the indicated Districts, it is estimated that one worker can treat one acre a day, given appropriate weather and equipment conditions. The Health Risk Analysis classifies these areas as "Right-of-way/Riparian Projects" and assumes a maximum application rate on 20 acres in one day for boom sprayer units and 3.3 acres in one day for workers with hand-held units. Tables B-4b, 5c, 6b, and 7c analyze the human health risk of this type of project.

Herbicide	Range of application rates used on the Forest
2,4-D only	2 lbs AI/A
Picloram	.25 lb AI/A
2,4-D/Picloram mix	2 lb AI/.25 lb AI/A
Glyphosate	1 lb AI/A

All of these rates fall within the Custer's Health Risk Analysis (discussed later in this Appendix) for the worst-case exposure and are considered to be within tolerable risk on the Custer National Forest and the Northern Region of the Forest Service.

Type 4 Project:

Noxious weeds treatment in this type of project fall in the riparian zone. Weed species encountered in this setting are leafy spurge, spotted knapweed, and Canada thistle. The proximity to water or water-influenced vegetation makes this a very delicate treatment. The infestations can be spotty to somewhat dense, although the sporadic occurrence is more common. Application methods are always hand-held from a backpack sprayer, controlled droplet applicator, or a vehicle-mounted tank if the terrain allows. Mitigation measures regarding treatment in the riparian are very specific (see Chapter II, Alternatives, Including the Proposed Action). The Health Risk Analysis classifies these areas as "Right-of-way/Riparian Projects" and would assume a maximum application rate on 3.3 acres in one day for workers with hand-held units. Tables B-4b, 5c, 6b, and 7c analyze the health health risk for this setting.

Herbicide	Range of application rates used on the Forest
2,4-D only	.5 lb AI/A to 2 lbs AI/A
Picloram	.25 lb AI/A
2,4-D/Picloram mix	2 lbs AI/.25 lb AI/A
Glyphosate	1 lb AI/A
Dicamba	1 lb AI/A

All of these rates fall within the Custer's Health Risk Analysis (discussed later in this Appendix) for the worst-case exposure and are considered to be within tolerable risk on the Custer National Forest and the Northern Region of the Forest Service.

HEALTH RISK ANALYSIS

The exposure rate and the doses to the affected population are based on several sources. Several studies have measured herbicide concentrations in pesticide workers and these findings are applied in this analysis. In some cases doses to the general population have been extrapolated from worker data in order to analyze worst-case impacts. In other cases dosage has been calculated based on maximum drift rates, dermal exposure and absorption rates, and food intake rates.

The general toxic effects of each herbicide are reviewed in this document. The LD_{50} values (lethal dose to 50 percent of a given population) for each chemical are reviewed to indicate the relative toxicity of these compounds. The "no observed effect levels" (NOEL) for chronic exposure to a chemical are reviewed. Both LD_{50} and NOEL values are provided for the animal species most sensitive to each herbicide.

In addition, this document provides acceptable daily intake (ADI) values for the herbicides of interest as determined by EPA review of the toxicity data for these compounds in the herbicide use registration process. ADI's are based on NOEL values using safety factors of 100 or greater.

The dose levels to maximum-exposed members of the affected population are compared to NOEL and ADI values for each of the herbicides of interest. This comparison indicates the possibility of adverse human health impacts from the maximum calculated dose.

A separate discussion of the carcinogenic and mutagenic potential of herbicide doses is provided in this analysis. Questions have been raised concerning the possible carcinogenicity of 2,4-D, picloram, and glyphosate. This analysis assumes

that a herbicide is a carcinogen if any animal test data indicate carcinogenic activity, no matter how weak.

Description of the Forest Service Spray Program and the Model Projects

Model projects provide the basis for determining the human health impacts of the Forest Service program to control noxious weeds. These models are based on the scope and design of the Forest Service control program as discussed below.

Herbicides can be applied at various application rates typically expressed as pounds of active ingredient (AI) per acre (lb/ac) or kilograms per hectare (kg/ha). Application rates depend primarily on the species of weed being controlled, and to a lesser extent, on site-specific variables such as soil types. Table B-1 provides application rates for various herbicides and mixtures of herbicides. These application rates will be used in the risk analysis with allowances for application errors.

In many cases, the prescribed application rates on the forest in Region 1 are lower than those provided in Table B-1. For example, picloram provides 99 to 100 percent control of knapweed for several years when applied at only one-quarter pound per acre. The use of the application rates on Table B-1 plus allowances for application errors will, in itself, overestimate potential impacts of many spray projects.

The definition of a spray project used in this analysis is somewhat arbitrary. Because the Forest Service strategy in many areas is to contain the spread of noxious weeds rather than chemically eradicate massive, firmly established populations, herbicide spraying is often directed toward scattered infestations. Thus, a 10-acre plot designated for spraying might only contain 5 one-quarter-acre areas of noxious weeds. Typically, each of these infested areas is sprayed individually with a portable spray applicator.

Obviously in large areas of spotty infestations, it becomes difficult to determine where one spraying project begins and one ends. For the purpose of tabulating and analyzing the data for this analysis, if two sprayed areas were further than one-half mile apart, they were considered separate projects.

In discussing a project, a distinction is made between gross and net area. Net area is the area actually sprayed with herbicide. Gross area is the area inside the smallest perimeter incorporating all the project spray areas and includes both the sprayed and unsprayed area. The gross area can often be 10 times or more than the net area.

Spraying projects can be divided into one of the three following categories based on locational variables: open-range/forest, road right-of-way (ROW), and riparian projects. Open-range/forest projects involve areas of National Forest System land used for grazing or for other agricultural, commodity, or wildlife purposes. Road right-of-way projects involve spraying strips of land immediately adjacent to roads traversing National Forest System land. Riparian projects involve spraying areas in which at least part of the herbicide is applied within 50 feet of flowing or standing water. Most herbicide spraying in riparian areas occurs with the spraying of road rights-of-way which often parallel stream channels. For this reason right-of-way and riparian location variables have been combined into one model project type.

TABLE B-1
PESTICIDE APPLICATION RATES

Pesticide	Nominal Application Rate in Kilograms/Hectare (pounds/acre)
2,4-D	2.2 (2)
Dicamba	1.1 (1)
Glyphosate	1.1 (1)
Picloram	1.1 (1)
2,4-D/Picloram[1]	1.1 (1)
	0.3 (0.25)

[1] Applied as a tank mix of 1 part 2,4-D to 0.25 parts picloram.

Although no actual project will look exactly like any one of the models, the risks involved in any actual project will almost certainly be less than the risks determined in the model project category to which it would be assigned. Although these model projects include extreme assumptions that will overestimate the risk from most, if not all actual projects, the Forest Service cannot absolutely guarantee that every project in the future will have less risk than a corresponding model project. The environmental analysis of each project will determine whether the project represents higher risk to affected populations than that calculated in the generic analysis.

The significance of the dose levels is determined in part by comparison to dose levels that produce general toxic effects. The toxic effects of a compound can be measured on any number of animals species using a variety of experimental protocol. The acute toxicity of a chemical compound is often indicated by the one-time or short-term dose that is lethal to 50 percent of a group of treated animals. This value is abbreviated as the LD_{50} and is expressed as the mass of compound (usually in grams, milligrams, or micrograms) administered per mass unit of organism (usually in kilogram's).

LD_{50} values will vary among species tested. Because there is no universally accepted method for determining which animal species would provide the most suitable model for effects on man, the LD_{50} value for the species most sensitive to a particular herbicide is considered. These values are based on a review of herbicide toxicology data provided by Agriculture Handbook 633 (USDA 1984).

Because lethality represents a rather extreme benchmark for judging the safety of herbicides, policies regarding acceptable intake levels for chemical compounds are most often based on toxicity tests designed to find the highest dose level that produces no effects in the animal species tested. This dose is the no observed effect level (NOEL). The NOEL is the dose level below the lowest dose level to affect the organism's health or well being over the test duration. A NOEL can be determined for acute (single dose or short-term), subchronic (generally 30- to 90-day dosing studies), and chronic tests of a compound. All other things being equal, the longer the dosing duration upon which a NOEL is based for a particular animal species, the more significant the resulting value.

In registering herbicides for use on agricultural commodities for human consumption or on feed for animals subject to human consumption, the Environmental Protection Agency (EPA) establishes tolerances for residues of herbicide. These tolerance levels are based on the toxicity data establishing NOEL's for the herbicide and a projection of human consumption patterns. Generally, EPA uses the NOEL from the chronic dose studies with the species that is most sensitive to the compound. In the absence of chronic exposure these results with the most sensitive species, the EPA does use subchronic test results with larger safety factors and the requirement of additional chronic testing. Table B-2 provides the NOEL's as used by EPA in setting tolerances for herbicide residues on human foodstuffs.

With the exception of picloram, all NOEL data proved on Table B-2 are based on 2-year feeding studies with either dogs or rats. The most recent tolerance limit determination for picloram by EPA was based on a 90-day dog-feeding study with a NOEL of 50 mg/kg/day. In the interim, Dow Chemical has been conducting additional tests. A recently completed 6-month dog-feeding study showed a NOEL of 7 mg/kg/day (Dow undated). Dow Chemical is currently conducting a 2-year rat-feeding study as reported by Roby (1984). Six-month and 12-month interim data are available from these tests. At 6 months, some liver anomalies were noted in animals dose at 60 mg/kg/day. However, these effects were not noted in animals sacrificed after 12 months of daily doses of 60 mg/kg. At 20 mg/kg/day, no effects were noted for either 6-month or 12-month dosing periods. Thus, 20 mg/kg/day would be a conservative interim NOEL value for this rat-feeding study.

Because the dog-feeding study provided a lower NOEL value, the value of 7 mg/kg/day, as obtained in the 6-month dog study, will be used as the NOEL value in this risk analysis.

The use of pesticides can cause concern over the possible prenatal effects from the exposure of pregnant women to such pesticides. Teratogenesis refers to irreversible malformations caused early in the development of the fetus, when organs are just forming. Teratogenesis should be distinguished from the term, fetotoxicity. Fetotoxicity refers to reversible effects on the fetus, such as lowered birth weight, delays in ossification, etc. These effects can be overcome upon removal of the toxicant.

Fetotoxic effects are often noted at lower doses than teratogenic effects and NOEL's can be determined for both fetotoxic and teratogenic effects for the herbicides of interest. This analysis provides the NOEL values for fetotoxicity or teratogenicity, whichever is lower.

The lowest fetotoxicity NOEL reported in USDA Handook 633 (USDA 1984) for dicamba is 3 mg/kg. By comparison the overall NOEL for any effect is 1.25 mg/kg.

TABLE B-2

SUMMARY OF ACUTE AND CHRONIC TOXICITY THRESHOLDS BASED ON RESULTS FROM THE MOST SENSITIVE SPECIES

Herbicide	Acute oral LD50 in mg/kg[1]	Chronic Toxicity NOEL in mg/kg/day	Reference for NOEL data
2,4-D	100	1.0	USEPA, 1985a
Dicamba	566	1.250	Fed. Register 3/15/83 p. 11119
Glyphosate	3,800	10.000	Fed. Register 12/22/83 p. 56581
Picloram	2,000	50.000	Fed. Register p. 41770
		20.000	Roby 1984
		7.000	Roby 1984

[1] Based on a review of Agriculture Handbook 633 (USDA 1984).

The herbicide 2,4-D has been subject to extensive study both in the past and as part of a data call-in for a review of registration data. A Russian fetotoxicity-teratogenicity study on 2,4-D has been reported to have shown fetotoxic effects at doses as low as 0.5 mg/kg (USDA 1984). Questions on the validity of this study have been raised because no information is available on impurities in the test compounds, solvents used, strain of rats used, etcetera. Because of this uncertainty, new testing has been conducted on 2,4-D. Recently a rat-feeding study on the teratogenic effects of 2,4-D has been conducted by Dow Chemical and a separate, independent feeding study completed by EPA. A fetotoxicity NOEL of 25 mg/kg was indicated by these studies and teratogenic effects were not induced (Spencer 1985).

A fetotoxicity NOEL of 1,000 ppm in food (50 mg/kg body weight) and a teratogenicity NOEL of 3,500 ppm in food (188 mg/kg) are reported by EPA for glyphosate (USDPA 1983c). By contrast the NOEL for any effects from glyphosate dosing is 10 mg/kg.

Picloram has very low teratogenic potential. Teratogenic and fetotoxic effects are not seen with picloram doses up to 500 mg/kg in animal tests (USDA 1984).

Table B-3 provides a summary of fetotoxicity NOEL values for the herbicides of interest. This table also provides a list of lifetime Acceptable Daily Intake values as determined by EPA in setting tolerance limits for herbicides on agricultural commodities. The ADI values assume that a person can be dosed daily at this level for a *lifetime* with no ill effects.

The time-honored approach for establishing an ADI or safe level of pesticide dose is to divide the threshold dose or NOEL established from chronic animal studies by a "safety factor" (Doull et al. 1980 and NAS-NRC 1977). The safety factors are needed to account for differences in duration of exposure, absorption, metabolism, and excretion between humans and test animals. For example, on a body-weight basis, man is generally more vulnerable to drugs than are experimental animals by a factor of 6-12 (NAS-NRC 1977). If the dose is scaled on a surface area basis, this increased vulnerability disappears.

In addition to accounting for differences between animal species and humans (interspecies differences), the safety factor should also account for differences among humans (intraspecies differences). For example, for the herbicides dicamba, 2,4-D, and glyphosate, the NOEL from chronic feeding studies with the most sensitive species was divided by 100 to arrive at the ADI. This safety factor of 100 can be considered to include a tenfold safety factor to account for the difference between animal species and humans and an additional tenfold safety factor to account for sensitive humans.

The lifetime ADI for picloram was calculated by dividing the 90-day dog-feeding study NOEL of 50 mg/kg by a safety factor of 2,000. The more recent NOEL data reported in this analysis will eventually work its way through the regulatory framework and may result in a higher ADI since less extreme safety factors would be required.

It could be argued that, considering the transient nature of most worst-case doses, an ADI for these

doses might be calculated by dividing a sub-chronic (e.g., 90-day) NOEL by a safety factor of 100. Even the spray applicators are typically involved in spraying for 30 days or less. However, the more conservative lifetime ADI values are provided on Table B-3.

In reviewing the dose/NOEL comparison on the tables, with but few exceptions discussed below, the worst-case doses to maximum-exposed members of the general population are all below ADI values. From the standpoint of general toxic effects (noncarcinogenic), a dose can be considered safe if it is below the ADI. The converse is not necessarily true, that is doses above the ADI are not necessarily harmful. The ADI presumes a daily dose everyday for a lifetime, and higher short-term doses can often be tolerated safely.

The dose comparisons show that the dose to a visitor to National Forest System lands could exceed the ADI's if he or she collects and consumes a large quantity of sprayed, unwashed vegetation. For numerous reasons, there is a very low probability of this event. Very little land is actually being sprayed for noxious weeds. The vegetation which is the target (knapweed, leafy spurge, thistle, etc.) is not edible. Finally, the appearance, odor, and taste of the sprayed vegetation would significantly reduce palatability of wild foods. At concentrations above 5 to 1 mg/kg (parts per million) on food, 2,4-D, picloram, and dicamba impart a bitter taste to food. Notwithstanding these consumption limiting factors, the calculated doses indicate that even if these improbable events were realized, adverse health impacts would be highly unlikely with such a transient dose.

The maximum estimated dose to an adolescent who stands within 1 meter (3 feet) of a right-of-way spray project could exceed the ADI for the herbicides 2,4-D and dicamba. This maximum estimate is about 5 times higher than a dose estimate based on extrapolations from actual measurements of project supervisors' doses and none of these more reasonable dose estimates exceed the ADI. Even the maximum dose estimates provide NOEL margins of safety of 20 or greater. For example, the dicamba NOEL is over 50 times greater than the dose. Because the NOEL and ADI presume long-term exposure, adverse impacts from this one-time dose are very unlikely. Short-term tests with dicamba reveal the following pattern. A 13-week feeding study with rats indicated a NOEL of 25 mg/kg (500 ppm in food) in contrast to a 2-year NOEL of 1.25 mg/kg. A one-time dicamba dose of 0.019 mg/kg is very unlikely to cause adverse health impacts since the dose is approximately 1,300 times less than the 13-week NOEL.

Large, open-range projects sprayed with 2,4-D in excess of 2 pounds (AI) per acre could result in a combination of doses to maximum-exposed individuals that would slightly exceed the ADI for 2,4-D. In the scenario, the largest dose comes from the consumption of drift-contaminated vegetables from a garden located within 220 yards of the spray site.

Many worst-case worker doses calculated in this analysis exceed EPA's ADI values. All workers involved in the direct hand application of liquid formulation could receive worst-case doses in excess of ADI values. In reaching conclusions on the relevance of these findings, it is appropriate to consider several factors.

TABLE B-3

MAXIMUM FETOTOXICITY NOEL FOR MOST SENSITIVE SPECIES AND ACCEPTABLE DAILY INTAKE (ADI) VALUES

Herbicide	Fetotoxicity NOEL in mg/kg/day	ADI Values in mg/kg/day	Reference for ADI
2,4-D	25	0.01	USEPA, 1985a
Dicamba	3	0.0125	Fed. Register 3/16/83 p. 11119
Glyphosate	50	0.1	Fed. Register 12/22/83 p. 56581
Picloram	500	0.0250	Fed. Register 9/22/82 p. 41770

TABLE B-4a

NOEL/DOSE AND ADI/DOSE COMPARISONS FOR MAXIMUM-EXPOSED RESIDENTS AND VISITORS IN THE VICINITY OF A LARGE, OPEN-RANGE PROJECT SPRAYED WITH 2,4-D, PICLORAM, 2,4-D MIXTURE, GLYPHOSATE OR DICAMBA.

	2,4-D		Picloram		2,4-D/picloram		Glyphosate		Dicamba	
	NOEL	ADI	NOEL	ADI	NOEL	ADI	NOEL	ADI	NOEL	ADI
Adult resident	95	Above[1]	1,224	4.4	178/3,659	1.8/13	1,780	18	222	2.2
Adolescent resident	94	Above	1,223	4.4	177/3,657	1.8/13	1,766	18	220	2.2
Infant resident	75	Above	992	3.5	137/2872	1.4/10	1,370	14	171	1.7
Visitor re-entry	125	1.2	7,750	6.2	250/6,363	2.5/23	2,500	25	312	3.1
Visitor re-entry with consumption of sprayed wild food	18	Above	250	Above	36/1,000	Above/3.6	357	3.6	45	Above

[1] Dose is above the ADI.

TABLE B-4b

NOEL/DOSE AND ADI/DOSE COMPARISONS FOR MAXIMUM EXPOSED RESIDENTS AND VISITORS IN THE VICINITY OF RIGHT-OF-WAY PROJECTS SPRAYED WITH 2,4-D, PICLORAM, DICAMBA, GLYPHOSATE, OR 2,4-D/PICLORAM MIXTURE.

	2,4-D		Picloram		2,4-D/Picloram		Dicamba		Glyphosate	
	NOEL	ADI	NOEL	ADI	NOEL	ADI	NOEL	ADI	NOEL	ADI
Adult resident	144	1.4	2,023	7.2	287/8,088	2.8/29	359	3.6	2,875	29
Adolescent resident (dermal and oral dose)	21	Above[1]	1,119	4.0	42/4,250	Above/15	55	Above	445	4
Adolescent resident (oral doses only)	114	1.1	1,606	5.7	229/6,100	2.3/22	361	3.6	2,891	29
Infant resident	101	1.0	1,425	5.1	200/5,982	2/21	249	2.5	1,104	11
Visitor re-entry	568	5.7	7,954	28	1,136/30,435	11/109	1,420	14	11,363	114

[1] Dose is above the ADI.

First, several worst-case assumptions serve to increase estimates of worker dose. For example, it is assumed that dose is a direct linear function of the amount applied. Thus, if a backpack applicator applies twice the amount in a exposure study (Lavy et al. 1984), then it assumed that the applicator's dose will be twice the baseline dose. This relationship is open to the question since in Lavy's study backpack sprayers often saturated with herbicide mix although these workers generally sprayed less active ingredient in a day than assumed here. It is possible that they received a maximum dose and that spraying additional active ingredient in a work day would have no effect on dose.

As noted throughout this document, in the absence of readily attainable data on specific parameters very conservative (i.e., worst-case) assumptions were made that tend to overestimate dose. Less conservative and more realistic assumptions will provide lower dose estimates and increase the margin of safety.

The margins of safety for average workers as indicated by the NOEL/dose comparisons are greater than 10 for all herbicides. These margins of safety are probably sufficient to protect the average worker from general toxic effects such as kidney or liver dysfunction. These margins of safety are placed in a better light by considering the worker's typically limited extent of exposure (usually less than 30 days per year).

Higher doses are typically tolerated over shorter periods of time. For example, although dicamba shows relatively low margins of safety when com-

paring worker doses to long-term dose tests, short-term tests with dicamba indicate higher tolerance levels. No effects were noted at 7 weeks in rats fed dicamba at the highest levels tested (50 mg/kg). At 13 weeks, rats show histological changes in the liver at 40 mg/kg but not at 25 mg/kg. A similar pattern would probably be evidenced in dogs which are relatively sensitive to organic acids. The dicamba NOEL of 1.25 mg/kg used in this document is based on a 2-year feeding study with dogs.

Careless work habits and poor application techniques could result in worker doses with low margins of safety particularly with the herbicides 2,4-D and dicamba. At worker doses approaching the high or worst-case dose levels used in the comparisons in Tables B-5a, 5b, and 5c, possible liver and kidney anomalies could result from continued exposure (perhaps as low as 60 days) although these effects are typically reversible. For example, the kidney effects noted with 2,4-D at the lowest effect levels are reversible with cessation of dose even after 60 to 90 days of continuous exposure.

A second area of concern with higher dicamba doses is the possibility of fetotoxic or teratogenic effects. The fetotoxic NOEL is 3 mg/kg for dicamba and the teratogenic NOEL is 10 mg/kg. At the worst-case worker dose levels calculated in this analysis, it is not possible to offer assurances that the teratogenic effects of dicamba exposure can be avoided by reducing the length of time of herbicide exposure. It has been shown that many teratogens operate during relatively short time frames or critical periods in pregnancy. These periods generally occur in the early stages of pregnancy, often before pregnancy is confirmed. Thus, it is not the absolute length of exposure that is relevant, but its timing relative to the critical period. Therefore, because of the low teratogenicity margins of safety for workers spraying dicamba, restrictions on the use of women as herbicide applicators are advisable.

Margins of safety for fetotoxic and teratogenic effects for 2,4-D doses are considerably higher. Fetotoxic NOEL for 2,4-D is 25 mg/kg. Teratogenic effects were not seen at the highest doses tested.

Toxicity data for glyphosate and picloram indicate higher margins of safety. Site-specific analysis will indicate more closely the worst-case doses and msrgins of safety for maximum-exposed workers. For picloram and glyphosate, fetotoxic margins of safety for workers range from about 50 to over 500.

Several management constraints and mitigating activities can be recommended to reduce worker dose and possible health effects.

First, all workers must be advised explicitly of the hazards of these chemicals and instructed in the careful herbicide application techniques so as to reduce dose levels below worst-case values assumed here. Several studies have shown that work practices greatly effect worker exposure and dose.

Second, for some herbicides, such as 2,4-D and dicamba, restrictions on the amount of herbicide applied daily may be necessary for workers subject to higher exposure (e.g., backpack sprayers). Alternatively, application methods resulting in lower exposure to workers may be used. For example, use of trucks or tractors equipped with boom sprayers could be used in some areas. For workers in high-exposure occupations, such as backpack sprayers, application days should be limited to 30 days in a year for 2,4-D or dicamba.

Third, restrictions on the use of women as applicators are advisable for some herbicides. For example, because of the low teratogenicity margins of safety for workers spraying dicamba, restrictions on the use of women of child-bearing age as herbicide applicators may be necessary. These restrictions should be made on a site-specific basis depending on the projected worst-case worker dose and the toxicity data of the herbicide.

To evaluate the ability of the herbicides to produce genotoxic effects such as tumor initiation or heritable mutations, NOELs or thresholds doses are not used. Thresholds are not assumed because it is conceivable that only one or a few molecules of an active chemical may cause certain types of changes in DNA that could form neoplastically transformed cells (cancer) or heritable mutagenic effects (birth defects).

In the case of cancer, individual and population risks can be quantified using various models if there is scientific evidence to suggest a chemical is a carcinogen. Since quantitative risk models are not available for mutagenicity, a multi-step process of evaluating a pesticide's ability to cause mutations and to interact with germinal cells (cells involved in reproduction) is used to assess the qualitative potential of mutagenic risk in humans (see, for example, USEPA 1984a, or USEPA 1980). The first step involves an analysis of the evidence of a pesticide's ability to cause mutations in bacteria, microorganisms, insects, plants, mammalian cells in culture and germinal cells in whole animals; while the second step involves an analysis of its ability to produce these events in mammalian gonads. Greater weight is placed on tests that show changes in germinal cells and tissues than in somatic cells, on tests performed *in vivo* (within the body) rather than *in vitro* (outside the body), and in mammalian species rather than in submammalian species (USEPA 1984b).

TABLE B-5a

NOEL/DOSE AND ADI/DOSE COMPARISONS FOR BACKPACK SPRAYERS ON LARGE, OPEN-RANGE PROJECTS[1]

	Minor Mixing Errors	Major Mixing Errors
2,4-D	1.2	1.2
Picloram	18	18
Dicamba	3.1	2.9
2,4-D/Picloram	2.5/70	2.3/63
Glyphosate	25	23

[1] All worker doses are above the ADI.

TABLE B-5b

NOEL/DOSE AND ADI/DOSE COMPARISONS FOR TRUCK DRIVERS AND SUPERVISORS ON LARGE, OPEN-RANGE PROJECTS

	Supervisor		Truck Driver	
	NOEL	ADI	NOEL	ADI
2,4-D	125	1.2	1.5	Above[1]
Picloram	1,750	6	21	Above
Dicamba	312	1.2	1.5	Above
2,4-D/picloram	250/6,363	2.5/23	3.0/88	Above
Glyphosate	2,500	25	30	Above

[1] Doses are above the ADI.

TABLE B-5c

NOEL/DOSE AND ADI/DOSE COMPARISONS FOR WORKERS ON RIPARIAN/RIGHT-OF-WAY PROJECTS

	Truck Driver		Spot Sprayer	
	NOEL	ADI	NOEL	ADI
2,4-D	6.2	Above[1]	1.2	Above
Picloram	88	Above	18	Above
Dicamba	16	Above	3.1	Above
2,4-D/picloram	12/350	Above/1.2	2.5/70	Above
Glyphosate	125	1.2	25	Above

[1] Worker dose is above the ADI.

Most significant in determining mammalian carcinogenic and heritable mutagenic potential are long-term feeding studies. Single generation feeding studies can determine the carcinogenic potential while multigenerational feeding studies can define the potential for reproductive disruption. However, because a wider variety of cellular systems can be tested in an economical and timely fashion, the tiered mutagenesis testing routine outlined above provides a useful screening system.

The mutagenesis testing results are reviewed below for the herbicides of interest. In reviewing these results, the trends are most significant since no individual mutagenesis test is perfectly predictive and every test can give false positives and false negatives.

Extensive reviews of the mutagenesis literature for the herbicides of interest are provided in Agriculture Handbook 633 (USDA 1984). Highlights of these reviews and the EPA mutagenesis data summaries provided in tolerance determinations are reported below.

2,4-D Mutagenesis Tests

As reviewed in Agriculture Handbook 633 (USDA 1984), 2,4-D is generally nonmutagenic in most of the microbial systems investigated. Equivocal results were obtained in tests with human lymphocytes with both positive and negative results being reported. Assays for detecting unscheduled DNA synthesis with human embryonic lung cells both in the presence and absence of metabolic activation systems were negative. However, as is discussed below, 2,4-D will be assumed to be a carcinogen based on ambiguous evidence from whole animal tests.

Tests of potential for initiation of heritable mutations including tests with *Drosophila* and tests for mouse dominant lethal mutations are all reported to give nonmutagenic results (USDA 1984). A three-generation rat feeding showed no reproductive impairment at doses up to 1,500 ppm in food (USEPA 1982b).

Dicamba Mutagenesis Tests

Dicamba has not shown mutagenic potential in mutagenesis tests ranging from *S. typhimurium* to human fibroblasts. A 3-year rat reproduction study also showed no effects at dicamba levels as high as 500 ppm in food (USEPA 1983a). Based on these results, dicamba is not considered mutagenic.

Glyphosate Mutagenesis Tests

As reported in Agriculture Handbook 633 (USDA 1984), microbial mutagenesis tests with eight strains of bacteria and yeasts all showed no mutagenic effects for glyphosate. No evidence of mutagenicity was observed in the dominant lethal mutation assays with mice.

Picloram Mutagenesis Tests

Picloram has shown no mutagenic potential in a standard battery of microbial mutagenesis assays. Only in unvalidated assay systems did picloram show mutagenic activity (USDA 1984).

In a study to determine possible cytogenic effects on bone marrow cells in animals, picloram was fed to rats at dosages up to 2,000 mg/kg without adverse effects.

As is discussed below, ambiguous evidence from whole animal carcinogenesis studies form the basis for assuming that picloram is a carcinogen in this risk analysis.

Carcinogenic Potential of Herbicides

In keeping with the worst-case basis of this risk analysis, a herbicide is considered to have carcinogenic potential if whole animal test data indicates oncogenic activity no matter how weak.

EPA is currently reviewing toxicity test data for 2,4-D and has requested additional testing of this compound. An on-going chronic (2-year) rat-feeding study will be completed in 1986. In the interim, there have been at least two studies of the carcinogenic potential of 2,4-D.

As part of a study involving a large number of chemicals, Innes et al. (1969) exposed mice of two strains orally to two different formulations of 2,4-D for 18 months. Eighteen mice of each sex and each strain were exposed to each formulation. Exposure to 2,4-D did not result in any significant increases in tumors in this experiment.

Hansen et al. (1971) exposed Osborne-Mendel rats to 0, 5, 25, 125, 625, or 1,250 ppm 2,4-D in the diet for 2 years. There were 25 male and 25 female rats in each dosage group. No significant effect of dosage on survival was noted. Total numbers of rats with tumors in the control group was 15, and the tumors in the treated groups, by increasing dose, were 14, 18, 20, 23, and 22. Because the tumors were typical of those normally found in aging Osborne-Mendel rats and no target organ tumors were involved, the authors did not attribute these lesions to the feeding of 2,4-D. If one were to assume a relationship between dose and tumor incidence, it is possible to calculate statistical upper limits on the carcinogenic potency of 2,4-D from the studies described above. These upper limits on the carcinogenic potency of 2,4-D will be calculated using a one-hit model of cancer. This model is the most conservative (i.e., predicts the highest risks) of any of the cancer models which have gained some acceptance. The one-hit model assumes no threshold or, in other words, that even a single molecule of 2,4-D might cause

cancer. This model was used for a time by the EPA to estimate cancer risks before being replaced by a less conservative multistage model of cancer.

The one-hit model was fit separately to the male and female rat data on total animals with tumors from Hansen et al. (1971) using the computer program GLOBAL82 (Howe and Crump 1982). The data on females gave the largest 95 percent statistical upper limit on the carcinogenic potency of 2,4-D (i.e., largest 95 percent upper limit on the linear term in the one-hit-3model of cancer). This upper limit was 3.01×10^{-5} per ppm or 5.03×10^{-4} per (mg/kg/day).

The data on the carcinogenic potential of picloram are also ambiguous. The National Cancer Institute (1978) conducted a bioassay of picloram and interpreted the findings as "suggestive of ability of the compound to induce benign tumors in livers of female Osborne-Mendel rats." The benign lesion that suggested this effect was foci of cellular alteration in liver. The one-hit model can be applied to data on this lesion in the manner described for 2,4-D. The 95 percent upper limit calculated in this fashion for the carcinogenic potency of picloram in 3.4×10^{-5} per ppm or 5.68×10^{-4} per (mg/kg/day). This value is approximately one-tenth of the 2,4-D value.

EPA is currently reviewing glyphosate carcinogenicity studies submitted by Monsanto (IBT replacement studies). Feeding studies (2-year) with both rats and mice have been conducted. Well conducted rat studies showed no oncogenic activity in either sex. A mouse study is currently being reviewed by EPA. In brief, this 2-year mouse oncogenicity (cancer) study was conducted with glyphosate feed levels of 1,000 parts per million (ppm) in food; 5,000 ppm in food; 30,000 ppm in food; and a control group. Each feed level was comprised of 50 animals of each sex.

The number of male mice with tumors (renal tubular adenomas) was 0 at the 1,000 ppm group, 1 in 5,000 ppm group, and 3 in the 30,000 ppm group. No females had tumors at any dose level. There is some controversy over whether there was one or 0 tumors in the male control (untreated) animals. EPA has ordered Monsanto to recut and reexamine tissues from these animals to resolve the controversy. As noted in the 2,4-D studies, tumors in the control (untreated) mice are not unusual although tumors of the type found in this study have rarely been found in untreated (control) mice.

In reviewing the oncogenicity studies of glyphosate, several conclusions can be drawn. First, these feeding studies reaffirm the relatively low toxicity of glyphosate. The highest dose levels of 30,000 ppm means that 3 percent of the mouse daily food intake was glyphosate.

Second, the weight of evidence as indicated by both mouse- and rat-feeding studies indicates at most weak oncogenic effect from glyphosate dose.

In summarizing the information on glyphosate oncogencity, EPA (1985) has concluded:

> Thus, in well-conducted oncongenicity studies on both sexes of two species, the incidence of only one tumor type in one sex of one species was found to have an increase related to treatment with glyphosate. This increase in tumors occurred only at very high exposure levels (much higher than usual in long-term studies of pesticides). Furthermore, the positive finding depends upon the presence of tumors in only four treated animals.
>
> The factors listed in the paragraph above indicate that the evidence for oncogencity, though present, is extremely limited. According to the Agency's proposed carcinogen risk assessment guidelines (49 FR 46294), glyphosate would be classified in Category C which is used for agents with limited evidence of carcinogenicity in animals in the absence of human data. Category C is the lowest weight-of-evidence category among the categories with any positive evidence.
>
> In addition to the limited amount of quantitative evidence supporting a conclusion of oncogenicity, a quantitative risk estimates indicates that, to the extent that glyphosate is actually an oncogen, it is likely to have only a weak oncogenicity effect. This is primarily related to the extremely high doses at which effects were observed in the study as compared to likely human exposure. Therefore, based on the information currently available, the Agency does not expect any significant risk from the level of glyphosate to which humans are likely to be exposed.

This risk analysis assumes that glyphosate is a carcinogen. The 95 percent limit of the cancer potency calculated from the kidney tumor data is 3.4×10^{-5} per (mg/kg/day).

Chronic tests of the herbicide dicamba, as reviewed in USDA 1984, indicates no carcinogenic potential for this compound.

The probability of the occurrence of cancer over a lifetime as a result of exposure to 2,4-D, picloram, or glyphosate can be determined using the following equation:

$Pc = q^* \times D \times De/L$

where

Pc = worst-case estimate of the probability of cancer as a result of the dose

q^* = the upper limit of the carcinogenic potency slope (5.03×10^{-3} per (mg/kg/day) for 2,4-D; 5.68×10^{-4} per (mg/kg/day) for picloram; and 3.4×10^{-5} per (mg/kg/day) for glyphosate

D = daily dose in mg/kg/day

De = number of days during which the daily dose occurs

L = days in a lifetime (25,550)

Using this equation, the incremental probability of cancer in a lifetime from each exposure pathway can be calculated for model projects applying 2,4-D, picloram, or glyphosate. For example, the probability of a worker with a backpack sprayer developing cancer after spraying 2,4-D for 1 day (with a major mixing error) on small, open-range projects is 8.3×10^{-8} (5.03×10^{-3} per (mg/kg/day) x 0.42 mg/kg/day x 1 day x lifetime/25,550 days). A cancer probability of 8.3×10^{-8} means that the worker has about eight chances in one hundred million of developing cancer as a result of this dose. The worker's probability of cancer as a result of 30 days spraying assuming he gets a worst-case dose each day is 2.5×10^{-6} ($30 \times 8.3 \times 10^{-8}$) or about 2½ chances in one million. If over the 30 days the worker gets an average dose as measured by Lavy et al. (1984), his cancer probability would be about one-fourth the worst-case probability or about six chances in 10 million.

Calculation of the cancer probabilities for various members of the general population requires an estimate of the daily dose and the number of days over which the dose will occur. The maximum-exposed resident in the vicinity of a large, open-range project is assumed to receive a drift dose for 3 days, to consume drift-contaminated vegetables for 42 days and herbicide-contaminated beef for 140 days. The herbicide concentration on vegetation is assumed to remain constant for 2 weeks, to fall to one-half initial values for the next 2 weeks, and by another one-half for the next 2 weeks. This step function decrease in concentration will overestimate concentrations for relatively persistent pesticides such as picloram. The combination of physical and biological degradation, removal by rain and/or irrigation, and new growth will reduce concentrations at a faster rate than assumed here.

In addition to the routes of exposure for residents near open-range projects, residents near right-of-way projects were assumed to get a one-time dose from eating contaminated fish and drinking contaminated water.

The cancer probabilities for the general population are provided in the Analysis of Human Risk in Region 1 for each exposure pathway and include consideration of dose duration (in days). For example, the cancer probabilities provided on Table B-6a for a large, open-range for an adult resident and visitor are calculated as follows:

Drift:	probability = 1.3×10^{-10} = 5.03×10^{-3} per (mg/kg/day) x 2.2×10^{-4} mg/kg/day x 3 days x lifetime/25,550 days.
Oral dose beef:	probability = 2.0×10^{-8} = 5.03×10^{-3} per (mg/kg/day) x 7.1×10^{-4} mg/kg/day x 140 days x lifetime/25,550 days
Oral dose vegetable:	probability = 4.6×10^{-8} = 5.03×10^{-3} per (mg/kg/day) x (9.6×10^{-3} mg/kg/day x 14 days + 4.8×10^{-3} x 14 days + 2.4×10^{-3} x 14 days) x lifetime/25,550 days
Visitor re-entry:	probability = 1.6×10^{-9} = 5.03×10^{-3} per (mg/kg/day) x 8.0×10^{-3} mg/kg/day x 1 day x lifetime/25,550 days
Oral dose wild food:	probability = 1.1×10^{-8} = 5.03×10^{-3} per (mg/kg/day) x 5.6×10^{-2} mg/kg/day x 1 day x lifetime/25,550 days.

The cumulative impact on the maximum-exposed resident from doses from each of the exposure pathways is the sum of the probabilities from the individual pathways. For the maximum-exposed adult resident near a large, open-range project sprayed with 2,4-D (see Tables B-6a and B-6b), the probability from all three exposure pathways is 6.613×10^{-8} ($1.3 \times 10^{-10} + 2.0 \times 10^{-8} + 4.6 \times 10^{-8}$) or about six chances in one hundred million. If this resident were exposed to five projects in a lifetime and each time received the maximum dose (in itself a very, very low probability event), his probability of cancer would be 3.3×10^{-7} or about three chances in ten million.

Considering all herbicides used, the highest cancer probability occurs with an infant resident near a large, open-range project sprayed with 2,4-D. The infant's cumulative cancer probability is 8.1×10^{-8} or about eight chances in one hundred million.

As a point of comparison and to further illustrate the reality of such small probabilities, Table B-8 provides a list of events which result in a one-in-a-million chance of death. As shown on Table B-8, the average American has about a one-in-a-million chance of being killed in fire for every 13 days of living in the U.S. His probability of fire fatality for 1 year would be about 2.8×10^{-5} (1×10^{-6}/13 days x 365 days/year), or about three chances in 100,000. A worker in the transport and public utilities section of industry (e.g., a truck driver) has a one-in-a-million chance of death every day on the job. A person who smokes two cigarettes has increased his probability of cancer by one chance in a million.

TABLE B-6a

CANCER PROBABILITIES FOR VISITORS AND RESIDENTS IN THE VICINITY OF A LARGE, OPEN-RANGE PROJECT SPRAYED WITH 2,4-D, PICLORAM, GLYPHOSATE, OR 2,4-D/PICLORAM MIXTURE

	Cancer probability (2,4-D)	Cancer probability (picloram)	Cancer probability (glyphosate)	Cancer probability 2,4-D dose in mixture	Cancer probability picloram dose in mixture
Adult dermal dose	1.3×10^{-10}	7.3×10^{-13}	4.3×10^{-13}	6.5×10^{-11}	2.0×10^{-13}
Adolescent dermal dose	1.8×10^{-10}	1.0×10^{-12}	6.0×10^{-13}	8.9×10^{-11}	2.7×10^{-13}
Infant dermal dose	3.3×10^{-10}	1.8×10^{-12}	1.1×10^{-12}	1.6×10^{-10}	4.7×10^{-13}
Adult/adolescent oral dose (beef)	2.0×10^{-8}	2.2×10^{-9}	1.3×10^{-10}	2.0×10^{-8}	2.2×10^{-9}
Infant oral dose (beef)	2.3×10^{-8}	2.6×10^{-9}	1.5×10^{-10}	2.3×10^{-8}	2.6×10^{-9}
Adult/adolescent oral dose (veg)	4.6×10^{-8}	2.6×10^{-9}	1.6×10^{-10}	2.3×10^{-8}	6.5×10^{-10}
Infant oral dose (veg)	5.8×10^{-8}	3.4×10^{-9}	2.0×10^{-10}	3.0×10^{-8}	8.7×10^{-10}
Visitor re-entry to spray site 1 day	1.6×10^{-9}	8.9×10^{-11}	5.3×10^{-12}	7.9×10^{-11}	2.4×10^{-12}
Oral dose/sprayed wild food 1 day	1.1×10^{-8}	6.2×10^{-10}	3.7×10^{-11}	5.5×10^{-9}	1.6×10^{-10}

Synergism, which concerns many people, is a special type of interaction where the combined effect of a specific herbicide with one or more chemicals in the environment (such as pollutants) would be greater than the sum of the individual effects of the herbicide and chemical(s) (in other words 2 + 2 is greater than 4).

Chemical interactions may also result in antagonistic effects in which two or more chemicals cause opposite effects on the same physiologic function or decrease the intrinsic activity of one of the components. Most cases of chemical interactions lead to a a decrease in toxicologic activity, and this is one of the common principles of antidotal treatment (U.S. EPA 1984c). Examples include the use of chelating agents to complex with metal ions and the use of ammonia as an antidote to the ingestion of formaldehyde. By comparison, chemical reactions which lead to greater than additive effects appear to be less common and are less well documented.

Since we live in a sea of chemicals, the possibility of chemical/herbicide interaction is certainly probable. However, because of the complex number of possible interactions, the result is not readily predictable.

One way to measure interactive effects is to conduct epidemiological studies on exposed and control populations. However, the interactive effects described are measurably small and the sensitivity of epidemiology tests might not be sufficient to detect such effects particularly at the dose levels occurring with most spray programs and with the small number of people involved.

A classic study of the synergistic effects of pollutants examined the interactive effects of asbestos exposure and smoking. Selikoff et al. (1968) found that inhalation of cigarette smoke and asbestos resulted in an eightfold increase in lung cancer over nonsmokers exposed to only asbestos. Studies such as these, however, have limitations because high doses are required to discover effects and the relevance to low level exposures is uncertain.

Tests for synergistic effects can sometimes be accomplished using short term animal or cellular tests at relatively high dosage levels. For example, Stathan and Lech (1975) have reported the synergistic effects of the pesticide carbaryl on the acute toxicity of 2,4-D in trout, as well as the pesticides dieldrin, rotenone and pentachlorophenol. The acute toxicity of these chemicals was increased by factors of threefold to about eightfold for additions of 1 mg/liter of carbaryl. This amount of carbaryl is much higher than would be present in water under any circumstance except worst-case accident scenarios.

TABLE B-6b

CANCER PROBABILITIES FOR VISITORS AND RESIDENTS IN THE VICINITY OF RIPARIAN/RIGHT-OF-WAY PROJECTS SPRAYED WITH 2,4-D, PICLORAM, GLYPHOSATE, OR 2,4-D/PICLORAM MIXTURE

	Probability from 2,4-D dose	Probability from picloram dose	Probability from glyphosate dose	Probability from 2,4-D dose in mixture	Probability from picloram dose in mixture
Adult dermal dose	7.9×10^{-12}	4.4×10^{-14}	2.7×10^{-14}	3.9×10^{-12}	1.1×10^{-14}
Adolescent dermal dose	7.5×10^{-9}	4.2×10^{-11}	2.5×10^{-11}	3.7×10^{-9}	1.1×10^{-11}
Infant dermal dose	1.9×10^{-11}	1.1×10^{-13}	6.4×10^{-14}	9.4×10^{-12}	2.7×10^{-14}
Adult/adolescent oral dose (beef)	2.0×10^{-10}	2.2×10^{-11}	1.3×10^{-12}	2.0×10^{-10}	2.2×10^{-11}
Infant oral dose (beef)	2.3×10^{-10}	2.6×10^{-11}	1.5×10^{-12}	2.3×10^{-10}	2.6×10^{-11}
Adult/adolescent oral dose (veg)	4.8×10^{-9}	2.8×10^{-10}	1.7×10^{-11}	2.5×10^{-9}	7.1×10^{-11}
Infant oral dose (veg)	6.3×10^{-9}	3.5×10^{-10}	2.1×10^{-11}	3.2×10^{-9}	8.2×10^{-11}
Visitor re-entry or walk along ROW	3.5×10^{-10}	2.0×10^{-11}	1.2×10^{-12}	1.7×10^{-10}	5.1×10^{-12}
Adult oral dose (water)	1.1×10^{-9}	6.4×10^{-11}	3.9×10^{-12}	5.7×10^{-10}	1.6×10^{-11}
Adolescent oral dose (water)	1.5×10^{-9}	8.4×10^{-11}	5.1×10^{-12}	7.5×10^{-10}	2.2×10^{-11}
Infant oral dose (water)	1.6×10^{-9}	9.3×10^{-11}	5.6×10^{-12}	8.3×10^{-10}	2.4×10^{-11}
Adult/adolescent oral dose (fish)	2.0×10^{-11}	1.1×10^{-12}	6.4×10^{-14}	9.5×10^{-12}	3.8×10^{-13}
Infant oral dose (fish)	2.2×10^{-11}	1.2×10^{-12}	7.4×10^{-14}	1.1×10^{-11}	4.2×10^{-13}

TABLE B-7a

DAILY CANCER PROBABILITIES FOR BACKPACK SPRAYERS ON LARGE, OPEN-RANGE PROJECTS

	Cancer probability assuming minor mixing errors	Cancer probability assuming major mixing errors
2,4-D	1.6×10^{-7}	1.7×10^{-7}
Picloram	8.9×10^{-9}	9.3×10^{-9}
Glyphosate	5.3×10^{-10}	5.7×10^{-10}
2,4-D/Picloram	7.9×10^{-8}/ 2.2×10^{-9}	8.5×10^{-8}/ 2.4×10^{-9}

TABLE B-7b

DAILY CANCER PROBABILITIES FOR TRUCK DRIVERS AND SUPERVISORS ON LARGE, OPEN-RANGE PROJECTS

	Supervisor	Truck driver
2,4-D	1.6×10^{-9}	1.3×10^{-7}
Picloram	8.9×10^{-11}	7.3×10^{-9}
Glyphosate	5.3×10^{-12}	4.4×10^{-10}
2,4-D/picloram	7.9×10^{-10}/	6.5×10^{-8}/
	2.2×10^{-11}	1.8×10^{-9}

TABLE B-7c

DAILY CANCER PROBABILITIES FROM WORKERS SPRAYING RIPARIAN/RIGHT-OF-WAY PROJECTS

	Truck Driver	Spot Sprayer
2,4-D	3.2×10^{-8}	1.6×10^{-7}
Picloram	1.8×10^{-9}	8.9×10^{-9}
Glyphosate	1.1×10^{-10}	5.3×10^{-10}
2,4-D/picloram	1.6×10^{-8}/	7.9×10^{-8}/
	4.4×10^{-10}	2.2×10^{-9}

In tests run by Dow Chemical Company on humans at unspecified doses (USDA 1984), no dermal irritation or sensitization was found for mixtures of 6 percent Tordon (picloram) and 22 percent 2,4-D, 10.2 percent picloram and 39.6 percent 2,4-D salts, or 10 percent picloram only.

In summary then, what can be said concerning the issue of synergistic and cumulative effects relative to the Forest Service noxious weed spray programs? First, the additive impact of Forest Service spraying on top of general effects of the private application of herbicides will be very small. For example, a worker or farmer who was spraying herbicides on non-Forest Service projects and who was also a resident in the vicinity of Forest Service projects might expect, under worst-case conditions, an increase in herbicide dose of less than 1 percent over his worker dose. Typically, the increase would not be measurable.

The dose to maximum-exposed residents assumed that the greatest portion of their diet came from spray-impacted foodstuffs. Thus any substitution of food from other sources (i.e., food markets) would lessen the dose. The herbicides most commonly used on the forest in Region 1 have not been found widely in market foodstuffs. For example, a market-basket analysis by the Natural Resources Defense Council (NRDC) of a variety of fruits and vegetables found no 2,4-D in any food sample (NRDC 1984).

Although the NRDC found other pesticides in some foodstuffs, the interactive effects would be suspected to be small for maximum-exposed residents. Since the dose or concentration of any chemical dictates both the probability and rate of any chemical reaction (and all biological responses in an organism are the result of chemical reactions), the dose of a specific herbicide in the environment or in the individual is an important factor in considering synergistic effects. Ames (1983) pointed out that there are many naturally occurring chemicals in the food people eat which are teratogenic, mutagenic, and carcinogenic and which are consumed at doses 10,000 times higher than man-made pesticides. Therefore, the low, short-lived doses to maximum-exposed residents that result from the spraying of these herbicides to control noxious weeds are very small compared to many other chemicals in the environment. For these small comparative doses, a synergistic effect is not realistically expected (Crouch et al. 1983). EPA apparently came to the same conclusion, because they issued a Notice (PR Notice 82-1) on January 12, 1982 (U.S. EPA 1982a), rescinding the requirement for submission of tank mix compatibility data. The Notice stated that EPA had examined considerable data and found no evidence of potentiation involving pesticides.

As discussed throughout this analysis, the high-

est doses are expected of some types of workers, particularly those involved in the hand application of herbicides. If one assumed synergistic reactions on the order of those observed in the case of asbestos exposure and smoking, then eight to tenfold increases in toxicity might be expected. The most significant impacts might involve workers spraying 2,4-D/dicamba mixtures, one of the more common mixtures used in Region 1. Again, the major concern would be the potential fetotoxic effects on pregnant female applicators. Depending on site-specific plans and needs, this issue may require additional consideration in the site-specific analysis and could require management constraints.

TABLE B-8

LIFETIME RISK OF DEATH OR CANCER RESULTING FROM EVERYDAY ACTIVITIES.

Activity	Time to accumulate a one-in-a-million risk of death	Average annual risk per capita
	Living in the United States	
Motor vehicle accident	1.5 days	2×10^{-4}
Falls	6 days	6×10^{-5}
Drowning	10 days	4×10^{-5}
Fires	13 days	3×10^{-5}
Firearms	36 days	1×10^{-5}
Electrocution	2 months	5×10^{-6}
Tornados	20 months	6×10^{-7}
Floods	20 months	6×10^{-7}
Lightning	2 years	5×10^{-7}
Animal bite or sting	4 years	2×10^{-7}
	Occupational Risks	
General		
manufacturing	4.5 days	8×10^{-5}
trade	7 days	5×10^{-3}
service & government	3.5 days	1×10^{-4}
transport & public utilities	1 day	4×10^{-4}
agriculture	15 hours	6×10^{-4}
construction	14 hours	6×10^{-4}
mining and quarrying	9 hours	1×10^{-3}
Specific		
coal mining (accidents)	14 hours	6×10^{-4}
police duty	1.5 days	2×10^{-4}
railroad employment	1.5 days	2×10^{-4}
fire fighting	11 hours	8×10^{-4}

Other One-In-A-Million Risks

Source of risk	Type and amount of exposure: examples
Cosmic rays	One transcontinental round trip by air; living 1.5 months in Colorado compared to New York; camping at 15,000 feet over 6 days compared to sea level.
Other	20 days of sea level natural background radiation; 2.5 months in masonry rather than wood building; 1/7 of a chest x-ray using modern equipment.
Eating & drinking	40 diet sodas (saccharin) 6 pounds of peanut butter (aflatoxin) 180 pints of milk (aflatoxin) 200 gallons of drinking water from Miami or New Orleans 90 pounds of broiled steak (cancer risk only)
Smoking	2 cigarettes

[1] From Crouch and Wilson (1982)

APPENDIX C
CHEMICAL HAZARD ASSESSMENT

(From Northwest Area Noxious Weed Control Program EIS, BLM, 12/85)

Appendix available upon request

APPENDIX D

TOXICITY OF DIOXINS IN HERBICIDES PROPOSED FOR USE

(From Northwest Area Noxious Weed Control Program EIS, BLM, 12/85)

Much confusion exists because of the use and misuse of the term dioxin. The term can refer to any one of about 75 polychlorinated dibenzodioxins (PCDD). But to many people, dioxin has become synonymous with 2,3,7,8-T4CDD, the only known dioxin with toxicity of any significance. The confusion has been compounded by free use of the abbreviations DCDD (for dichlorodibenzodioxin) and TCDD (for tetrachlorodibenzodioxin). There are 22 compounds of tetrachlorodibenzodioxins, and each compound acts differently in the environment. Common use of the term TCDD to mean 2,3,7,8-tetrachlorodibenzo-p-dioxin has caused some readers to assume all TCDDs are of the same toxicity, which is not the case. For example, 2,4-D studies have found traces of several dichloro-, trichloro-, and tetrachlorodibenzo-p-dioxin impurities, but none are thought to be particularly toxic (NRCC 1981). Recent studies, such as the 1981 Canadian publication "Polychlorinated Dibenzo-p-Dioxins: Criteria for their Effects on Man and His Environment" (NRCC 1981), refer to each specific PCDD by name, which clears up much of the confusion.

Manufacturing processes have been refined over the past few years to reduce impurities. A trade memorandum from Agriculture Canada's Food Production and Inspection Branch, dated August 28, 1981, stated, "Through this review, it has been possible to identify certain technical products that can be expected to be virtually free of PCDDs" (NRCC 1981).

Of the herbicides proposed for use by alternatives discussed in this EIS, only 2,4-D has been found to contain dioxins, and these dioxins are practically nontoxic (NRCC 1981). The following discussions have been extracted and included here for clarification. The term TCDD used in the extracts refers to 2,3,7,8-T4CDD.

Impurities occur in many organic synthesis procedures. Dioxins are among the trace impurities in all the phenoxys. There are 75 chlorinated dibenzodioxins, of which many occur in the chlorinated phenols and products made from them. Three dioxins have been found in 2,4-D, of which all are of limited toxicity. The initial finding of chlorodioxins in 2,4-D of Canadian manufacture (Cochrane and others 1980) showed substantial levels in certain formulations. U.S. EPA immediately assayed 30 formulations manufactured in the U.S. and in 3 samples found traces of 2,7-dichlorodibenzo-p-dioxin, the species to be expected in 2,4-D manufacture. No sample contained more than 60 ppb, which does not represent a toxicologic concern.

Extract from DOE, BPA 1983, page A-145. Chlorodibenzodioxins other than TCDD are of less concern because of low toxicity. Schwetz and others (1973) reported that 2,4-dichlorodibenzo-p-dioxin and octachlorodibenzo-p-dioxin have low toxicity whereas TCDD was extremely toxic. Low dosages of TCDD (0.0005 to 0.001 mg/kg/day) were toxic to rats, whereas 1,2,3,4-tetrachlorodibenzo-p-dioxin, 2,7-dichlorodibenzo-p-dioxin, 2,3-dichlorodibenzo-p-dioxic, and 2-chlorodibenzo-p-dioxin at dosages up to 2 mg/kg/day had little or no effect (Khera and Ruddick 1973).

2,4-D is synthesized from 2,4-dichlorophenol and therefore does not contain TCDD (Bovey and Young 1980). Three other chlorodibenzodioxins of low toxicity have been found in 2,4-D manufactured in Canada (Cochrane and others 1980). Analysis of 30 U.S. samples of 2,4-D revealed 2,7-dichlorodibenzo-p-dioxin in three formulations. No sample contained more than 60 ppb of 2,7-dichlorodibenzo-p-dioxin, which does not represent a toxicologic concern (Newton and Dost 1981). As part of the National Cancer Institude bioassay, a 2-year feeding study was conducted. Male and female rats and mice were fed 10 ppm (10,000 ppb) 2,7-dichlorodibenzo-p-dioxin. The panel of the National Cancer Institute concluded that 2,7-dichlorodibenzo-p-dioxin was not a carcinogen.

APPENDIX E

SUSCEPTIBILITY OF COMMON PLANTS TO CONTROL BY 2,4-D, DICAMBA, PICLORAM, AND GLYPHOSATE HERBICIDES

(Compiled from Klingman and Others 1983)

(From Northwest Area Noxious Weed Control Program EIS, BLM, 12/85)

Appendix available upon request

APPENDIX F

STATUS OF BIOCONTROL AGENTS ON THE CUSTER NATIONAL FOREST

(Compiled from Nowierski 1985 and Isaacson and Ehrensing 1977)
(From Northwest Area Noxious Weed Control Program EIS, BLM, 12/85)

Euphorbia pseudovirgata (*E. esula* x *virgata* complex) — leafy spurge

1. *Hyles euphorbiae* - leafy spurge hawkmoth

Moth has established on leafy spurge at two locations in Montana near Bozeman and Missoula. No other reports of establishment of the moth in the EIS area. Redistribution of moth a possibility this year. Moth larvae defoliate plant.

2. *Oberea erythcrocephala* - stem and root boring beetle

Beetle has established at possibly two locations in Montana. Population levels are still too low for redistribution.

3. *Chamaesphecia tenthrediniformis* - clear winged moth

Failed to establish on our type of leafy spurge.

4. *Apthona flava* - flea beetle

Screening research completed. May get approval for release in 1986. Adults chew shot holes in the leaves; larvae feed on roots.

5. *Lobesia euphorbiana* - leaf tying moth

Screening research continuing. Larvae tie up the leaves and feed internally, destroying the shoot and preventing seed production.

6. *Bayeria capitigena* - gall forming midge

Screening research completed. May get approval for release in 1986. Larvae gall up the seed producing region of the plant, reducing seed production.

Centaurea maculosa — spotted knapweed

1. *Urophora affinis* and *U. quadrifasciata* - seed head flies

Both species well established throughout EIS area (Idaho, Montana, Oregon, Washington, and Wyoming). Redistribution efforts are going on annually in Missoula, Montana. Larvae form galls in seed head, reducing amount of seed produced, and act as metobolic sink stressing plant.

2. *Metzneria paucipunctella* - seed head moth

Moth established in small population in Idaho, Oregon, and Washington. Climate apparently too severe in Montana for establishment. Larvae destroy seed.

3. *Pelochrista medullana* - root boring moths

Released in Montana near Missoula in 1984. Status of moth not known. Larvae destroy young rosettes.

Centaurea diffusa — diffuse knapweed

1. *Urophora affinis* and *U. quadrifasciata*

See information on flies under spotted knapweed.

2. *Sphenoptera jugoslavica* - root boring beetle

Believed established in Washington. Collections possible from Canada, where beetle is well established. Established in Oregon.

3. *Agapeta zoegana* - root boring moth

Released near Missoula, Montana, in 1984. Status of moth unclear. Larvae destroy young rosettes.

4. *Sclerotinia*

This fungus occurs naturally in Montana. It has been spread artificially to sites where it does not naturally occur.

Cirsium arvense — Canada thistle

1. *Ceutorhynchus litura* - stem boring beetle

Established at a few sites in Montana. Slow to increase and spread on its own.

2. *Urophora cardui* - gall fly

Established at one location in Montana at low population levels. Status in other states not known.

3. *Sclerotinia*

This fungus occurs naturally in Montana. It has been spread artificially to sites where it does not naturally occur.

Linaria dalmatica — dalmation toadflax

1. *Calophasia lunula* - defoliating moth

Released in Montana a number of times. No report of establishment in EIS area. Need economic data on dalmation toadflax before more agents are released (conflict with snapdragons).

Carduus natans — musk thistle

1. *Rhinocyllus conicus* - seed head weevil

Weevil apparently well established in EIS area, particularly in Montana. Larvae effectively destroy the seed producing region of the flower heads, possibly dramatically reducing seed production. However, musk thistle is still a problem in areas of the seed head weed establishment.

2. *Trichosirocalus horridus* - crown feeding weevil

Releases have been made in Montana in two different years. No report of establishment yet. Larvae destroy the meristem of the plant, causing lateral shoot growth and a more prostrate plant that cannot compete as well.

3. *Ceutorhynchus trimaculatus* - crown feeding weevil

Screening research continuing. Same type of damage as *Trichosirocalus horridus*.

Hypericum perforatum — Klamath weed, goat weed, St. Johnswort

1. *Chrysolina quadrigemina* - defoliating beetle

Beetle well established in EIS area. Where well established often provides 90+% successful control.

2. *Agrilus hyperici* - root boring beetle

Well established in California and probably Oregon, Idaho, and Washington. No report of establishment in Montana. Impact has not been investigated.

3. *Zeuxidiplosis giardi* - gall forming midge

Released in a number of states in EIS area. No report of establishment or effect in the Northwest. Larvae form galls on stem of plant.

It is too early to assess the effect of some biological agents in the noxious weeds. For example: *Obecea, Metznecia, Pelochrista, Urophora, Ceatorhynchus,* and *Colepnorea*. In other cases an individual biological agent does not provide adequate weed control. Therefore, a complex of 3 or more biological agents are required to accomplish an economic control level.

There are periodic severe outbreaks of weeds due to a breakdown of control because of insufficient populations of biological agents. Often times climatic conditions gave severe adverse impacts on biological agent populations.

APPENDIX G

SOIL AND WATER CHARACTERISTICS OF THE CUSTER NATIONAL FOREST

SOILS

Adsorption

Reaction of herbicide molecules and soil particles is related to both the characteristics of the soil and of the chemical to be used. Light-textured soils (sandy textures) have much less surface area and less of the chemical can be adsorbed and retained. Fine-textured soils (clays and clayer loams) have large amounts of particle surface upon which chemicals can be adsorbed. Soil particles are generally charged negatively so that positively charged molecules are attracted and held. This phenomenon is also known as colloidal binding. Fine-textured soils have a large percentage of these very small (colloidal) sized particles which carry negative charges because of the nature of their crystalling structure.

In general, more of the applied herbicide will stay onsite where soils are finer textured. Organic material also enhances adsorption.

Nature of Soil Horizons

Most of the Custer National Forest soils have rather low levels of organic matter (O.M.) because of the limited moisture and resulting moderate or low levels of vegetative growth. Soils in swales and on northerly aspects generally contain more O.M.

Six of the ten "Soil Orders" are represented in soils of the Custer National Forest. Of these six orders, the Aridisols and Entisols have lowest levels of organic material.

Inceptisols and Alfisols have developed somewhat more horizonation and contain more O.M.

Mollisols have rather dark colored surface horizons because of their higher O.M. content. They often show more distinctive horizons including a zone of clay accumulation (B horizon).

Histosols are soils made of plant material. They occur only on the high Beartooth Mountains in areas where moisture is not limiting to plant growth. There are no plans for herbicide application on these soils.

Soil textures are determined both by the original parent material and by soil development processes. Many of our dryer site soils have fine textures because they developed from fine-textured sediments. Textures become finer as a soil develops, but there is no direct relationship between texture and soil order.

Custer National Forest soils show a great variety of characteristics. In general, those on the Sheyenne National Forest are sandy textured, but some of them do have moderate levels of O.M. due to good vegetative growth. Water table is present within 2 to 4 feet on much of this district.

Most soils in the Grand River and Little Missouri National Grasslands are finer textured although some areas have sandy soils. They have low to moderate O.M. levels and fairly well developed horizons. Water tables are deeper but they often follow coal seams.

The Sioux and Ashland Divisions have soils ranging from fine-textured on gentle slopes to sandy and gravelly on hilly topography. Organic matter content is low to moderate.

Textures in the Pryor Mountains are fine to moderate and depend mostly on geology. O.M. is generally low.

The Beartooth Mountains have mostly glacial soils with moderate to coarse textures and low O.M. content. Organic soils of the swamps and high country are an exception. Organic soils bind chemicals quite strongly so that removal by leaching is unlikely and biological degradation is slow because of cool temperatures.

Soil Moisture Content

Soil moistures at time of application are generally below field capacity (0 to 10 bars), but available moisture is at its greatest depth. Most of the soils on the Custer National Forest only show evidence of annual water penetration to about 1½ to 2 feet. June is the peak of moisture on prairie and northern plains areas so that chemical degradation should occur most rapidly at time of application. With dryer weather in July and August, the herbicides should not be leached into soils to a significant degree.

Soil pH

Most soi1s are mildly acid to moderately alkaline. Some soils are strongly alkaline but these sites are nearly devoid of vegetation and application is not necessary.

Soil Temperature

Temperature regimes range from mesic through frigid and down to the pergelic subgroup in organic soils on the Alpine Beartooth Plateau. Most soils where herbicides are likely to be used

are in mesic and frigid classes. Application is done in the warmest months when degradation is most rapid.

Leaching

Chemical leaching through the soil depends on characteristics of the chemical and its lifespan before being degraded as well as the type of soil material. The behavior of herbicides proposed for use is summarized in Table G-1 and discussed below (taken from Northwest Area Noxious Weed Control Program Final Environmental Impact Statement, BLM, December 1985).

The persistence of 2,4-D has been studied in a variety of soil types and under a wide range of environmental and laboratory conditions. Persistence of 2,4-D in most soils is short and is generally less than 1 month (Ashton 1982). Norris (1983) found the half-life of 2,4-D in soil to be 1 to 4 weeks with little potential for bioaccumulation. In general, 2,4-D is relatively mobile in soil compared with other herbicides (Ghassemi and others 1981). Microbial degradation is the major mechanism by which 2,4-D is lost from the soil, especially under warm moist conditions with high soil organic matter—conditions that stimulate the growth of microorganisms. 2,4-D is not thought to leach into streams (Norris 1981) because it is adsorbed to soil organic material and rapidly degraded by soil microorganisms. Only minor losses of 2,4-D activity occur due to photodecomposition and, for most formulations, due to volatilzation.

The fate of picloram in soil is determined by several factors, including volatilization, photodecomposition, adsorption and leaching, runoff, and chemical and microbial degradation. Volatilization is not considered a major determinant of environmental fate because of the low vaor pressure of picloram.

Picloram is degraded by natural sunlight and ultraviolet light, although tbe extent of photodecomposition under field conditions has not been measured.

Picloram is generally considered to be a mobile herbicide because its adsorption to soil particles is low. The mobility of picloram is less in soils high in organic matter.

Preliminary studies with various soil types found that picloram is usually confined to the upper 1 foot of the soil profile when application rates are low (less than 1 pound/acre), but that picloram can readily move to depths greater than 3 feet, even in relatively dry areas, when the application rate is high (3 to 8 pounds/acre) (NRCC 1974).

The persistence of picloram in soils is considered to be moderate to high because it may exist at phytotoxic levels for a year or more after normal application (Mitchell 1969, NRCC 1974). Picloram persistence in soil is related to both treatment rate and climate. The half-life of the compound has been reported to range from more than 4 years in arid regions to 1 month under highly favorable conditions of moisture, temperature, and organic content of the soil (NRCC 1974). On the other hand, two studies of picloram persistence in arid and semiarid soils suggest that application rates not exceeding 1 pound/acre/year significantly reduce the potential for accumulation in the soil; Scifres and others (1971) reported that studies on semiarid rangeland in northwest Texas found dissipation of 0.25 pound/acre of picloram from the

TABLE G-1

BEHAVIOR OF HERBICIDES IN SOILS

Active Ingredient/Common Name	Behavior in Soil
2,4-D	Degradability in soil depends on microbial activity but is fast in organic and moist soils. Persistence is short, and mobility is relatively high.
Dicamba/Banvel	Moderately persistent, does not adsorb readily to soil particles, and is highly mobile. Mainly lost from soil by microbial decomposition.
Glyphosate/Roundup, Rodeo	Strongly adsorbed by soil. Adsorption is higher with organic soils and lowest in sandy soils. Decomposes rapidly by microorganisms.
Picloram/Tordon	Highly stable in plants, can be leached, relatively nonvolatile. Moderately to highly persistent in soil. Relatively mobile.

soil profile within a year and usually within 90 days under warm dry conditions. Residues usually were restricted to the top 12 inches, at least for 60 days. Five ppb or less were detected below 12 inches 120 to 180 days after application. Vore and others (1982) reported that studies on different soi1 types in Wyoming showed the highest concentration of picloram was in the top 8 inches of soil. At applications of 1 pound/acre, concentrations ranged from 0.991 to 0.062 ppm after 117 days. As a comparison, the acceptable picloram tolerance level for forage grasses is 80 ppm (40 CFR 180.29).

Dicamba has a moderate (3 to 12 months) persistence in soil compared to other herbicides (Ashton 1982). Dicamba does not adsorb readily to soil particles and colloids and thus has a high degree of mobility in most soils. The major route for loss of dicamba in soil appears to be microbial degradation rather than chemical degradation or photodecomposition.

Glyphosate is completely and rapidly degraded in soil by microbial degradation. In soil, glyphosate resists chemical degradation, is stable to sunlight, is relatively nonleachable, has a low tendency to runoff, is strongly adsorbed to soil particles, has a negligible volatility, and only slightly affects soil microflora. Because of its strong adsorption to soil particles, glyphosate is relatively immobile in most soil environments.

Movement with Runoff and/or Eroded Soil

2,4-D, dicamba, and picloram are relatively mobile in soil compared with other herbicides. This mobility is influenced by soil pH and by the formulation of the product used. Glyphosate is strongly adsorbed on soil particles and therefore is not apt to migrate except when attached to eroding soil particles.

A study with 2,4-D applied for brush control on hill pastures in southern Oregon (Norris and others 1982) found that during 7 months following application, 4-5 grams of 2,4-D were discharged into streams, representing 0.014 percent of total amount applied. They concluded that most of the herbicide discharged into streams in this study were deposited in dry stream channels or from streambanks.

Ghassemi and others (1981) reviewed the persistence and fate of dicamba in aquatic systems. Because dicamba salts are highly water soluble and rapidly enter the soil, sufficient residues are unlikely to remain for transport via precipitation runoff into nearby waterbodies. Frank and Sirons (1980) found dicamba residues (0.7 parts per billion (ppb)) in only 1 of 949 stream samples after dicamba was applied to watershed soils.

Because of its mobility, picloram may be carried by surface runoff to nontarget areas, including streams and ponds. Runoff, however, removes less than 3 percent of the total picloram applied to soil, and the concentration of Picloram in runoff generally decreases with time as well as with the time between application and the first rainfall (Trichell and others 1968 in National Research Council of Canada 1974). Other factors that decrease the concentration of picloram in runoff include decreases in the slope of the terrain, the use of slow-release granular formulations rather than liquids, and the distance over which the runoff flows.

The strong adsorption of glyphosate to soil particles greatly reduces its mobility through leaching and surface washout. Rueppel and others (1977) tested the mobility of glyphosate in three different soils by means of soil thin-layer plates spotted with radiolabelled glyphosate. These plates were washed twice with water, and the final distribution of radiolabelled glyphosate was determined by beta camera analysis after each washing. On all three soils tested, even after the second washing, glyphosate moved only a short distance, indicating that it is an immobile herbicide.

Comes and others (1976) investigated the leaching of residues from irrigation canal banks treated with glyphosate. They detected neither glyphosate nor its metabolite, aminomethyl phosphonic acid, in the first flow of water through canals that had been dry for 23 weeks after glyphosate had been sprayed on the ditch banks at a rate of 5 pounds/acre.

Most lands of the Custer National Forest experience low volumes of water runoff ranging from 0.4 inch annually on the Ashland Division to about 2.5 inches in the Pryor Mountains. The Beartooth Mountains produce a much larger volume, averaging 22 inches annually.

Runoff peaks are the result of summer thunderstorms on all districts except the Beartooth. Thus, the largest flows are likely to occur near the application period. However, many watersheds produce no measurable runoff for 2 or 3 years at a time.

Volatization

Picloram and glyphosate have low vapor pressures and do not volatilize to a significant extent. Dicamba may volatilize from the soil surface but further work is necessary to define the significance (Frear 1976). Certain formulations of 2,4-D volatilize much more than others; esters in partic-

ular are known to be volatile. Formulations to be used on Custer National Forest lands are low-volatile forms such as amines and low volatile esters.

Degradation Processes

Custer National Forest lands are located in the northern plains where mean annual temperatures are quite low. However, the vary warm summer temperatures and high insolation rates, chemical and microbial degradation can be rather rapid.

2,4-D has been studied extensively and its persistence is short, generally less than a month (Ashton 1982).

Dicamba has a calculated half-life of 17 to 32 days in Oklahoma (Altas and Stritzke 1973). Only traces remained after a year in New Zealand soils. Higher temperatures and moisture caused more rapid degradation.

Glyphosate evidently does not dissipate to a great extent via chemical degradation. It is degraded at a fairly rapid rate by microbial activity and has a persistence of about 1 month.

Picloram is the most persistent of the herbicides proposed for use on the Custer National Forest. Its half-life is reported to range from 1 month to more than 4 years, depending on climatic conditions. In temperate climates, its persistence is about 1 year. As with the other chemicals, soil moisture and microbial activity have a strong influence on rate of degradation.

Photodegradation

None of the herbicides proposed for use is significantly degraded by light when in the soil.

Uptake of Herbicides by Higher Plants

Any of the herbicides can affect nontarget species that they contact. This can occur whether from leaf contact or by adsorption through roots. The effect is minor or nonexistent where application is by spot application with hand-held equipment.

Miscellaneous Factors

All herbicides being considered have low toxicities and are rapidly excreted by animals. Very small amounts will remain in animal tissue.

WATER QUALITY

Nature of the Water Present on Site

Water quality is very good in the Beartooth Mountains. Volumes produced are large and the water has many uses downstream.

Other areas of the Forest produce much smaller volumes of runoff and of considerably lower quality. Sediments are the major contaminants at high flows and dissolved solids (salts) peak during low flows. In the Little Missouri River, total dissolved solids are often between 1,000 and 2,000 mg/l. During higher flows, these streams often carry more than 10,000 mg/l of sediment, and over 1,000 tons of sediment per square mile may be removed from the land in the Little Missouri Badlands. The other districts produce less but still significant volumes of sediment. These streams, the few which are perennial, are warm water fisheries. Species are catfish, sauger, carp, and sucker.

Herbicides can be carried on sediment even when not very soluble in water or when having a strong affinity for soil particles (glyphosate).

Chemical Composition

The Beartooth Mountains produce water with very low levels of dissolved solids and mild acidity.

Water from the other districts is generally quite hard and often alkaline with pH usually above 7 and occasionally above 8. Literature indicates that some herbicides decompose more rapidly at higher pH and some at lower pH. Water from Custer National Forest lands ranges from moderately acid to strongly basic or alkaline. Conditions depend on location, season, and current climatic conditions.

Temperature

Most applications would occur in late spring or summer when temperatures are in high ranges. This should enhance degradation of chemicals that encounter water.

Dissolved Oxygen

Water coming from the Beartooth District has adequate oxygen to provide a good trout fishery. The remaining districts produce water with estimated marginal oxygen levels. Very little data exists because the water is ephemeral and most often exists only in stagnant pools.

Sediment and Detrilus

Waters of Custer National Forest districts (except Beartooth District) contain high volumes of suspended sediments which can carry herbicides. Literature indicates that several herbicides are degraded quite effectively by microorganisms in the sediments (Ghassemi et. al 1981). Picloram may be an exception but very little of it has appeared in water during a number of studies. Less than 3% of the material applied was in runoff water from rain shortly after application during research in Canada. This amount was reduced further with time lapse between application and first rainfall (Trichell et. al 1968). Other studies have shown very low levels of picloram loss in runoff water.

APPENDIX H
UNIQUE PLANTS

Scientific Name	Common Name	Location
Aster sericeus	Silky aster	North Dakota
Astragalus barrii	no common name	South Dakota
Astragalus gracilis	Milkvetch	North Dakota
Athyrium filix-femina	Sub-Artic lady-fern	North Dakota
Betula paperifera	Paper birch	Montana, South Dakota
Betula pumila	Dwarf birch	North Dakota
Campanula aparinoides	Bedstraw bedflower	North Dakota
Carex leptalea	Bristle-stalked sedge	North Dakota
Coryphantha missouriensis	Missouri ball cactus	North Dakota
Cyperus rivularis	Brook flat sedge	North Dakota
Cypriapedium parviflorum	Yellow ladyslipper	North Dakota
Cypriapedium reginae	Showy ladyslipper	North Dakota
Dryopteris cristata	Crested wood-fern	North Dakota
Dryopteris spinulosa	Spinulose wood-fern	North Dakota
Equisetum palustre	Horsetail	North Dakota
Eriogonum visheri	Visher's buckwheat	North Dakota, South Dakota
Eriophorum gracile	Slender cottongrass	North Dakota
Galium labradoricum	Labrador marsh bedstraw	North Dakota
Gymnocarpium dryopteris	Oak fern	North Dakota
Helianthemum bicknellii	Bicknell's hoary rockrose	North Dakota
Hypericum boreale	Northern St. Johnswort	North Dakota
Liparis loeselii	Bog twayblade	North Dakota
Menyanthes trifoliata	Common bogbean	North Dakota
Onoclea sensibilis	Sensitive fern	North Dakota
Ophioglossum vulgatum	Common adder's-tongue fern	North Dakota
Phlox alyssifolia	Alyssum-leaved phlox	North Dakota
Physaria brassicoides	Rydberg's mustard twinpod	North Dakota
Pinus flexilis	Limber pine	North Dakota
Platanthera leucophaea	Prairie white-fringed orchid	North Dakota, South Dakota
Populus balsamifera ssp. trichocarpa	Black cottonwood	North Dakota
Pycnanthemum virginianum	Virginia mountain-mint	North Dakota
Ribes inebrians	Squaw currant	North Dakota
Rorippa calycina	no common name	North Dakota
Salix pedicellaris	Bog willow	North Dakota
Thelypteris palustris	Marsh fern	North Dakota
N/A	Relict grasslands	South Dakota

APPENDIX I

PROPOSED WEED TREATMENT PROGRAM ON THE CUSTER NATIONAL FOREST

This appendix identifies the site-specific projects considered for treatment in the alternatives in this EIS. The vegetative type category represents grouped ecosystems on the Forest. Following this chart is the application rates and typical treatment methods for each of the vegetative types and identifies the noxious weeds found within them.

			VEGETATIVE TYPE				TYPE OF TREATMENT			
District	Species	Scientific Name	Grassland	Grass, Tree or Shrub	Forested	Riparian	Biological	Chemical	Mechanical	
Sheyenne	Leafy spurge	*Euphorbia esula*	X	X		X		2,4-D		
Sheyenne	Leafy spurge	*Euphorbia esula*	X	X				Picloram		
Sheyenne	Leafy spurge	*Euphorbia esula*	X	X				2,4-D-Picloram		
Sheyenne	Leafy spurge	*Euphorbia esula*	X					Picloram Beads*		
Sheyenne	Leafy spurge	*Euphorbia esula*	X	X	X		disease/insect			
Sheyenne	Leafy spurge	*Euphorbia esula*	X						mow/brush hog	
Sheyenne	Leafy spurge	*Euphorbia esula*	X					2,4-D-Picloram	burn	
Sheyenne	Leafy spurge	*Euphorbia esula*	X					2,4-D	mow	
Sheyenne	Leafy spurge	*Euphorbia esula*	X					Picloram	mow	
Sheyenne	Absinth wormwood	*Artemisia absinthum*	X					Picloram		
Sheyenne	Canada thistle	*Cirsium arvense*	X					Picloram		
Sheyenne	Perennial sowthistle	*Sonchus arvensis*	X					Picloram		
Sheyenne	Hemp	*Cannabis sativa*	X	X				2,4-D		

1985 inventoried noxious weed acres were: Leafy spurge - 5,163; Absinth wormwood - 10, Canada thistle - 5; Perennial sow thistle - 2; Hemp - 40

Denbigh Experiment Forest	Leafy spurge	*Euphorbia esula*			X			2,4-D		
	Leafy spurge	*Euphorbia esula*	X					2,4-D-Picloram		

1985 inventoried noxious weed acres were: Leafy spurge - 100 acres

Beartooth	Spotted knapweed	*Centaurea maculosa*	X	X	X	X		2,4-D-Picloram		
Beartooth	Spotted knapweed	*Centaurea maculosa*	X	X	X	X		Glyphosate		Municipal Watershed
Beartooth	Spotted knapweed	*Centaurea maculosa*	X	X	X	X		Picloram		Municipal Watershed
Beartooth	Spotted knapweed	*Centaurea maculosa*	X	X	X	X		2,4-D		Municipal Watershed
Beartooth	Spotted knapweed	*Centaurea maculosa*	X	X	X	X	insect			Municipal Watershed

Note: The Municipal Watershed is subject to further analysis at the time of project proposal.

Beartooth	Spotted knapweed	*Centaurea maculosa*		X		X			pulling/grubbing	A - B Wilderness
Beartooth	Spotted knapweed	*Centaurea maculosa*		X		X	insect			A - B Wilderness

Note: Treatment in the Wilderness is subject to Regional Forester approval and is not approved in this EIS. A separate analysis tiered to this EIS will be prepared for the Regional Forester's approval.

Beartooth	Leafy spurge	*Euphorbia esula*		X				2,4-D-Picloram		
Beartooth	Dalmation toadflax	*Linaria dalmatica*		X				2,4-D-Picloram		
Beartooth	Canada thistle	*Cirsium arvense*		X				2,4-D-Picloram		

1985 inventoried noxious weed acres were: Leafy spurge - 3; Spotted knapweed - 114; Dalmation toadflax - 12; Canada thistle - 6

District	Species	Scientific Name	VEGETATIVE TYPE				TYPE OF TREATMENT		
			Grassland	Grass, Tree or Shrub	Forested	Riparian	Biological	Chemical	Mechanical
Sioux	Leafy spurge	*Euphorbia esula*	X	X				2,4-D	
Sioux	Leafy spurge	*Euphorbia esula*	X	X				Picloram beads*	
Sioux	Leafy spurge	*Euphorbia esula*	X	X				Picloram	
Sioux	Leafy spurge	*Euphorbia esula*	X	X				2,4-D-Picloram	
Sioux	Leafy spurge	*Euphorbia esula*	X	X			insect		
Sioux	Canada thistle	*Cirsium arvense*	X	X				2,4-D	
Sioux	Canada thistle	*Cirsium arvense*	X	X				Picloram beads*	
Sioux	Canada thistle	*Cirsium arvense*	X	X				Picloram	
Sioux	Canada thistle	*Cirsium arvense*	X	X				2,4-D-Picloram	
Sioux	Spotted knapweed	*Centaurea maculosa*	X	X				2,4-D	
Sioux	Spotted knapweed	*Centaurea maculosa*	X	X				Picloram beads*	
Sioux	Spotted knapweed	*Centaurea maculosa*	X	X				Picloram	
Sioux	Spotted knapweed	*Centaurea maculosa*	X	X				2,4-D-Picloram	
1985 inventoried noxious weed acres were: Leafy spurge - 150; Canada thistle - 10; Spotted knapweed - 40									
Ashland	Spotted knapweed	*Centaurea maculosa*	X					Picloram	
Ashland	Russian knapweed	*Centaurea repens*	X					Picloram	
Ashland	Canada thistle	*Cirsium arvense*	X					Picloram	
Ashland	St. Johnswort	*Hypericum perforatum*	X					2,4-D	
Ashland	Canada thistle	*Cirsium arvense*				X	fungus/insect		
Ashland	Spotted knapweed	*Centaurea maculosa*				X	fungus/insect		
1985 inventoried noxious weed acres were: Spotted knapweed - 454; Russian knapweed - 21; Canada thistle - 14; St. Johnswort - 1									
Grand River	Leafy spurge	*Euphorbia esula*	X					2,4-D-Picloram	
Grand River	Russian knapweed	*Centaurea repens*	X					2,4-D-Picloram	
1985 inventoried noxious weed acres were: Leafy spurge - 32; Russian knapweed - 8									
Medora	Spotted knapweed	*Centaurea maculosa*	X					Picloram	
Medora	Leafy spurge	*Euphorbia esula*	X					Picloram beads*	
Medora	Leafy spurge	*Euphorbia esula*	X					2,4-D-Picloram	
Medora	Leafy spurge	*Euphorbia esula*		X				Picloram beads*	
Medora	Leafy spurge	*Euphorbia esula*		X				2,4-D-Picloram	
Medora	Leafy spurge	*Euphorbia esula*	X	X			insect/disease		
Medora	Leafy spurge	*Euphorbia esula*	X	X					burn/mow
1985 inventoried noxious weed acres were: Leafy spurge - 2,500; Canada thistle - 5; Sotted knapweed - 5									

District	Species	Scientific Name	VEGETATIVE TYPE: Grassland	Grass, Tree or Shrub	Forested	Riparian	TYPE OF TREATMENT: Biological	Chemical	Mechanical
McKenzie	Leafy spurge	*Euphorbia esula*				X		Dicamba	
McKenzie	Leafy spurge	*Euphorbia esula*	X	X				2,4-D-Picloram	
McKenzie	Leafy spurge	*Euphorbia esula*		X				Glyphosate	
McKenzie	Leafy spurge	*Euphorbia esula*	X	X				Picloram beads*	
McKenzie	Leafy spurge	*Euphorbia esula*	X	X		X	insect		
McKenzie	Canada thistle	*Cirsium arvense*				X		Dicamba	
McKenzie	Canada thistle	*Cirsium arvense*	X					2,4-D-Picloram	

The 1985 inventoried noxious weed acres were: Leafy spurge - 175; Canada thistle - 30

* Dicamba beads may be substituted for picloram beads.

APPLICATION RATES ON THE CUSTER NATIONAL FOREST

Vegetative Setting	Herbicide	Application Rate[1]
Grasslands	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A to 1 lb AI/A
	2,4-D/Picloram	1 lb AI/.125 lb AI/A to 2 lbs AI/.5 lb AI/A
	Glyphosate	1 lb AI/A
Grass/tree and Grass/shrub	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	1 lb AI/.25 lb AI/A to 2 lbs AI/.5 lb AI/A
	Glyphosate	.75 lb AI/A to 1 lb AI/A
Forest	2,4-D only	2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	2 lbs AI/.25 lb AI/A
	Glyphosate	1 lb AI/A
Riparian	2,4-D only	.5 lb AI/A to 2 lbs AI/A
	Picloram	.25 lb AI/A
	2,4-D/Picloram	2 lbs AI/.25 lb AI/A
	Glyphosate	1 lb AI/A
	Dicamba	1 lb AI/A

[1]Application rates can exceed these rates and still be within legal label limits. However, additional health risk analysis must be made.

APPENDIX J
NORTHERN REGION HEALTH RISK ANALYSIS

The Northern Region Health Risk Analysis, "Analysis of Human Health Risk of USDA Forest Service Use of Herbicides to Control Noxious Weeds in the Northern Region," is attached as a separate document.

GLOSSARY

ADSORPTION: Adhesion of substances to the surfaces of solids or liquids; technically, the attraction of ions of compounds to the surfaces of solids or liquids.

ADVANCING HEADCUT: An erosional process in which the vertical erosion face (headcut) moves upslope or up a drainage.

ALLEOPATHIC: Pertaining to the suppression of growth of one plant species by another through the release of toxic substances.

ALLUVIAL DEPOSITS: Deposits of sand, gravels, and cobbles resulting from the reduction in carrying capacity of flowing water. As flowing water slows, its carrying capacity drops, allowing material to settle out.

AMINE: Any of a group of chemical substances derived from ammonia in which one, two, or three hydrogen atoms have been replaced by one, two, or three hydrocarbon groups.

ANIMAL UNIT MONTH (AUM): The amount of forage needed to sustain one cow and a calf (6 months old or younger) or their equivalent for 1 month.

ANNUAL PLANT: A plant that completes its life cycle within a year.

AUTHORIZED OFFICER: A designated Federal regulatory agency employee responsible for activities involving the use of public lands or delegated to exercise authority over grants for use of these lands.

BATHOLITH: A great mass of intruded igneous rock that for the most part stopped in its rise a great distance below the surface.

BETA CAMERA ANALYSIS: A method of analyzing movement of a radioactive isotope by recording on film the emittance of beta rays over a time interval.

BIENNIAL PLANT: A plant that completes its life cycle in 2 years.

BIOACCUMULATION: The accumulation of a substance in an ecosystem. A chemical that does not bioaccumulate, decomposes rapidly in the environment.

BIOASSAY: The testing of the effects of chemical substances on live organisms under controlled conditions.

BIOLOGICAL CONTROL: The use of natural enemies to attack a target plant, retard growth, prevent regrowth, or prevent seed formation.

BOOM (HERBICIDE SPRAY): A tubular metal device that conducts a herbicide mixture from a tank to a series of spray nozzles. A boom may be mounted beneath an aircraft or behind a tractor.

BROADCAST APPLICATION: The applying of herbicide over an entire area or field rather than only to rows, beds, or individual plants. See SPOT TREATMENT.

BROWSE: That part of a leaf and twig growth of shrubs, woody vines, and trees on which browsing animals can feed; to consume browse.

BUFFER (STRIP OR ZONE): A zone left untreated with herbicide (at the outer edge of a treated area or along streams) as protection against the effects of treatment.

CARBON 14 DATING: A method of dating archaeological and geological materials through the measurement of carbon 14—a heavy isotope of carbon of mass number 14.

CARCIOGENIC: A substance producing or inciting cancer.

CATEGORICAL EXCLUSION: A category of actions that do not individually or cumulatively have significant effects on the human environment and for which neither an environmental assessment nor an environmental impact statement is required.

CHEMICAL DEGRADATION: The breakdown of a chemical substance into simpler components through chemical reactions.

COLIFORM: A group of bacteria that normally abound in the intestines of humans and other warm-blooded animals and are used as an indicator of sanitary quality in water.

CONTACT SYSTEMIC HERBICIDE: A herbicide applied directly to a plant, which is absorbed in its leaves and then translocated throughout the plant.

CONTROL: Reduction of a pest problem to a point where it causes no significant economic damage.

CREEPING PERENNIALS: Perennial plants that spread by means of specialized modified aboveground stems (stolons) or below-ground stems (rhizomes) as well as by seeds. Because of their method of spread, creeping perennial noxious weeds are the most difficult to control.

CRITICAL HABITAT: (1) Specific areas within the habitat occupied by a species at the time it is listed under the Endangered Species Act where there are physical or biological features (i) essential to the conservation of the species and (ii) that may require special management considerations or protection, and (2) specific areas outside the habitat occupied by the species at the time it is listed upon the determination by the Secretary of the Interior that such areas are essential for the conservation of the species.

CRUCIAL WILDLIFE HABITAT: An area of habitat essential to the survival of any wildlife species sometime during its life cycle.

CULTURAL RESOURCES: Remains of human activity, occupation, or endeavor, reflected in districts, sites, structures, building, objects, artifacts, ruins, works of art, architecture, and natural features that were of importance in past human events. Cultural resources consist of (1) physical remains, (2) areas where significant human events occurred, even though evidence of the events no longer remains, and (3) the environment immediately surrounding the actual resource.

DERMATITIS: Inflamation of the skin.

DNA (DEOXYRIBONUCLEIC ACID): Any of the nucleic acids that are the molecular basis of heredity in many organisms.

DOSAGE: The regulation of doses; how often and for how long.

DOSE: The amount of chemical administered at one time.

DRIFT: The movement of airborne herbicide particles by air motion or wind away from an intended target area.

DRIP TORCH: A container of slash-burning fuel equipped with a wick to ignite the fuel mixture as it drips from the container onto the slash. Handheld torches have a 1.5-gallon capacity and are ignited by a fiber-filled, fuel-soaked wick. The torch used by a helicopter has a 30- to 55-gallon capacity and is equipped with an electrically activated fuel pump and ignition.

ECOLOGICAL NICHE: The physical space in a habitat occupied by an organism; its functional role in a community; and its position in environmental gradients of temperature, moisture, pH, soil, and other conditions of existence.

ENDANGERED SPECIES: Plant or animal species that are in danger of extinction throughout all or a significant part of their range. See THREATENED SPECIES.

ENVIRONMENTAL ASSESSMENT (EA): A systematic environmental analysis of site-specific activities used to determine whether such activities would significantly affect the human environment and whether an environmental impact statement is required.

ENVIRONMENTAL IMPACT STATEMENT (EIS): An analytical document developed for use by decisionmakers to weigh the environmental consequences of a potential action.

EPHEMERAL STREAM: A stream that flows only in direct response to precipitation and whose channel is at all times above the water table.

ESTER: A substance formed by the reaction between an acid and an alcohol, usually with the elimination of water.

EXCHANGE: A transaction in which the Federal government receives land or interests in land in exchange for other land or interests in land.

EXOTIC PLANTS: Plants that are not native to the region in which they occur.

FATE (HERBICIDE): What happens to a herbicide after it is applied, including leaching, photodecomposition, and microbial degradation.

FETOTOXIC: Toxic to a fetus.

FOOD CHAIN: A series of plant or animals species in a community, each of which is related to the next is a source of food.

FORAGE: All browse and herbaceous foods available to grazing animals. Forage may be grazed or harvested for feeding.

FORB: A low-growing herbaceous plant that is not a grass, sedge, or rush.

GELLED GASOLINE: A slash-burning fuel mixture containing an aluminum soap or fatty acid (alumagel) and gasoline. This gelling additive is mixed with gasoline at the rate of 7 pounds per 35 gallons.

GROUND COVER: Grasses or other plants that keep soil from being blown away or washed away.

HABITAT: The environment in which an organism occurs.

HALF-LIFE: The time required for half the amount of a herbicide introduced into a living system to be eliminated or disintegrated by natural processes.

HECTARE: 10,000 square meters or about 2.47 acres.

HERBACEOUS: Having little or no woody tissue and usually persisting for a single season.

HERBICIDE: A substance used to inhibit or destroy plant growth. If its effectiveness is restricted to a specific plant or type of plant, it is called a selective herbicide. If it is effective for a broad range of plants, it is called nonselective.

HERBIVORE: An animal that exclusively eats plants.

HISTOPATHOLOGIC: Pertaining to tissue changes characteristic of diseases.

INFILTRATION: The downward entry of water into the soil.

INSULT: Injury to the body or one of its parts or something that causes or has a potential for causing such injury.

INTEGRATED PEST MANAGEMENT: Use of several techniques (for example, burning, grazing and mechanical, manual, or chemical methods) as one system to control animals or plants where they are unwanted.

INTERMITTENT STREAM: A stream that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow.

IN VITRO: Outside the living body and in an artificial environment.

LABEL: All written, printed, or graphic matter on or attached to herbicide containers as required by law.

LC_{50}: A lethal herbicide concentration rate at which 50 percent of test animals will be killed. It is usually used in testing of fish or other aquatic animals.

LD_{50}: The dosage of toxicant (expressed in milligrams of toxicant per kilogram of animal body weight) required to kill 50 percent of the animals in a test population when given orally.

LEACHING: The movement of chemicals through soil by water or the movement of herbicides out of leaves, stems, or roots into the air or soil.

LIVESTOCK PERFORMANCE: The gaining of weight by livestock.

LOESS: Soil material carried and deposited by the wind, consisting predominantly of silt-sized particles.

METABOLISM: The chemical processes in living cells by which new material is assimilated and energy is provided for vital processes.

METABOLITE: Any substance taking part in or produced by metabolism.

MICROBIAL DEGRADATION: The breakdown by bacteria of chemical substances into simpler components.

MICROCLIMATE: Climatic conditions characteristic of a small area. Microclimates are influenced by local geography and vegetation and may differ from regional climate in temperature, wind, length of growing season, and precipitation.

MICROGRAM: One millionth of a gram.

MOBILITY (HERBICIDE): The capability of a herbicide to be moved easily within soil, vertically or laterally, with the normal movement of water.

MULTIPLE USE: The harmonious use of land for more than one purpose, not necessarily the combination of uses that will yield the highest economic return.

MUTAGEN: A substance that tends to increase the frequency or extent of genetic mutations (changes in hereditary material).

MYONEURAL: Of or relating to both muscle and nerve.

MYOTONIA: Tonic spasm of one or more muscles or a condition characterized by such spasms.

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS): The allowable concentrations of air pollutants in the air specified by the Federal government in Title 40, Code of Federal Regulations, Part 50. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety requisite to protect public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants). Welfare includes effects on soils, water, crops, vegetation, manufactured materials, animals, wildlife, weather, visibility, and climate; damage to and deterioration of property; hazards to transportation; and effects on economic values and on personal comfort and well being.

NATIONAL REGISTER OF HISTORIC PLACES: The official list, established by the historic Preservation Act of 1966, of the nation's cultural resources worthy of preservation. The Register lists archaeological, historic, and architectural properties (districts, sites, buildings, structures, and objects) nominated for their local, state, or national significance by state and Federal agencies and approved by the National Register Staff. The Register is maintained by the National Park Service.

NATIONAL TRAILS SYSTEM: A network of nationally significant trails consisting of (1) scenic, extended trails that provide outdoor recreation opportunities and conserve nationally significant scenic, historic, natural, or cultural qualities of areas through which they pass, and (2) recreation trails that provide a variety of outdoor recreation uses in or reasonably near urban areas.

NATIONAL WILD AND SCENIC RIVERS SYSTEM: A system of nationally designated rivers and their immediate environments that have outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural, and other similar values and are preserved in a free-flowing condition. This system consists of three types: (1) Recreation—rivers or sections of rivers readily accessible by road or railroad that may have some development along their shorelines and that may have undergone some impoundment or diversion

in the past; (2) Scenic—rivers or sections of rivers free of impoundments, with shorelines or watersheds still largely undeveloped but accessible in places by roads; and (3) Wild—rivers or sections of rivers free of impoundments and generally inaccessible except by trails, with watersheds or shorelines essentially primitive and waters unpolluted.

NEUROPATHY: An abnormal and usually degenerative state of the nervous system or nerves.

NONTARGET VEGETATION: Vegetation that is neither expected nor planned to be affected by herbicide treatment.

NO OBSERVED EFFECT LEVEL (NOEL): (1) the lowest dose of a substance by any route other than inhalation that has been found by experiment with animals to have no toxic effect on the animals or (2) the lowest concentration of a substance in air that has been found by experiment with animals to have no toxic effect on the animals exposed for a defined time.

NOXIOUS WEED: According to the Federal Noxious Weed Act (PL 93-629), a weed that causes disease or has other adverse effects on man or his environment and therefore is deterimental to the agriculture and commerce of the United States and to the public health.

ORGANOGENESIS: The formation of organs in animals.

OUTSTANDING NATURAL AREA: A natural area established to preserve scenic values and areas of natural wonder.

PALEONTOLOGY: A science dealing with life of past geological periods as known from fossils.

PARTICULATEs: Finely divided solid or liquid particles in the air or in an emission, including dust, smoke fumes, mist, spray, and fog.

PATHOGEN: A specific causative agent of disease, such as a bacterium or virus.

PERENNIAL PLANT: A plant that completes its life cycle in more than 2 years.

PERENNIAL STREAM: A stream that flows continuously year round.

PERSISTENCE: The resistance of a herbicide to metabolism and environmental degradation and thus a herbicide's retention of its ability to kill plants for prolonged periods.

PETIOLE: A slender stem that supports the blade of a foliage leaf.

pH: A numeric value that gives the relative acidity or alkalinity of a substance on a 0 to 14 scale with the neutral point at 7.0. Values lower than 7.0 show the presence of acids, and values greater than 7.0 show the presence of alkalis.

PHOTODECOMPOSITION (PHOTODEGRADATION): The breakdown of a substance, especially a chemical compound, into simpler components by the action of sunlight.

PHOTOSYNTHESIS: Formation of carbohydrates in the tissues of plants exposed to light.

PHYTOTOXIC: Poisonous to plants.

PRESCRIBED BURNING: The scientific, intentional burning of wildland fuels in either their natural or modified states under conditions to allow the fire to continue to a predetermined area and to produce the intensity of heat and rate of spread needed to meet certain objectives.

PRIORITY AREA: An area, usually in excess of 10 acres, infested with noxious weeds which has (1) been treated perpherally and shows an indication that control action on the interior will be effective, or (2) the possibility of facilitating greater noxious weeds spread by Forest users, animals, water or wind, or (3) the possibility of improving treatment effectiveness by coordinating with other control efforts, or (4) the possibility of improving treatment effectiveness by taking advantage of climatic and seasonal conditions.

RADIOLABELLING: A method of creating a radioactive isotope by bombarding a particle with beta or gamma rays. This method is used to trace the movement of particles in fluids.

RAPTORS: Birds of prey, such as owls, hawks, or eagles.

RESEARCH NATURAL AREA: A physical or biological unit in which current natural conditions are maintained insofar as possible. In such areas, activities such as grazing and vegetation manipulation are prohibited unless they replace natural processes and contribute to the protection and preservation of an area. Such recreation activities as camping and gathering plants are discouraged.

RHIZOME: An underground root-like stem, that produces roots and leafy shoots and provides a means for some plants to reproduce.

RIPARIAN: Pertaining to or located along a streambank or other water bodies, such as ponds, lakes, reservoirs, or marshes.

RISK: The probability that a substance will produce harm under specified conditions.

ROSETTE: A cluster of leaves in crowded circles or spirals arising basally from a crown or apically from an axis with greatly shortened internodes.

RUNOFF: The part of the precipitation in a drainage area that is discharged from the area in

stream channels, including surface runoff, ground water runoff, and seepage.

SCOPING: The process by which significant issues relating to a proposal are identified for environmental analysis. Scoping includes eliciting public comment on the proposal, evaluating concerns, and developing alternatives for consideration.

SEDIMENTATION: The process or action of depositing sediment.

SENSITIVE SPECIES (PLANTS): Plant species not officially listed as threatened or endangered but that are undergoing a status review or are proposed for listing by either Federal Register notices published by the Secretary of the Interior or the Secretary of Commerce or by comparable state documents.

SOIL COMPACTION: The compression of the soil profile from surface pressure, resulting in reduced air space, lower water-holding capacity, and decreased plant root penetrability.

SOIL COLLOID: An extremely small particle of clay or organic matter that exposes a large surface area on which some herbicides are absorbed.

SOIL PRODUCTIVITY: The capacity of a soil in its normal environment to produce a specified plant or sequence of plants under a specified system of management.

SOIL PROFILE: A vertical section of soil that shows all horizons and parent material.

SORPTION: The process of taking up or holding by either absorption or adsorption.

SOIL TREATMENT: Applying herbicide to a selected individual area as opposed to broadcast application.

STREAM CLASSES: Four classes of streams defined by present and foreseeable uses made of the water and potential effects on onsite changes on downstream uses. Because importance of use is relative to the general area, size is not necessarily a criterion for classification. Whole streams or parts of streams can be classified, and one stream may have sections in different classes.

Class I - Perennial or intermittent streams or segments that have one or more of the following characteristics: (1) are a direct source of water for domestic use (cities, recreation sites); (2) are used by large numbers of fish for spawning, rearing, or migration: (3) have enough water flow to greatly influence water quality of a Class I stream.

Class II - Perennial or intermittent streams or segments that have one or both of the following characteristics: (1) are used by moderate though significant numbers of fish for spawning, rearing, or migration; (2) have enough water flow to have only a moderate and not a clearly identifiable influence on downstream quality of a Class I stream or have a major influence on a Class I stream.

Class III - All other perennial streams or segments not meeting higher class criteria.

Class IV - All other intermittent streams or segments not meeting higher class criteria.

SUSPENDED SEDIMENT: Very fine soil particles that for long periods of time are maintained in suspension in water by turbulent currents or as colloids.

SUSTAINED YIELD: Achieving and maintaining a permanently high level, annual or regular period production of renewable land resources without impairing the productivity of the land and its environmental values.

TERATOGEN: A substance tending to cause development malformations in unborn human or animal offspring.

TERATOGENESIS: Birth defects.

THREATENED SPECIES: Plant or animal species that are not in danger of extinction but are likely to become so within the foreseeable future throughout all or a significant portion of their range. See ENDANGERED SPECIES.

TISSUE BURDEN: The cumulative effects of a substance on a particular tissue.

TOLERANCE: Acceptable level of pesticide residues.

TOTAL DISSOLVED SOLIDS (TDS): An aggregate of carbonates, bicarbonates, chlorides, sulfates, phosphates, and nitrates of calcium, magnesium, manganese, sodium, potassium, and other cations that form salts. High TDS solutions can change the chemical nature of water, exert varying degrees of osmotic pressure, and often become lethal to life in an aquatic environment.

TRANSLOCATION: The transfer of substances from one location to another in the plant body.

TUMORIGENIC: Causing tumors.

UNDERSTORY VEGETATION: Plants, usually grasses, forbs, and low shrubs, growing beneath the canopy of other plants.

UNGULATES: Hoofed mammals, most of which are herbivores and many of which have horns.

VAPOR PRESSURE: The pressure at which a chemical compound will evaporate.

VASCULAR PLANT: A plant that has a specialized conducting system consisting of xylem and phloem.

VISUAL INTRUSION: A feature (land, vegetation, structure) that is generally considered out of context with the characteristic landscape.

VISUAL RESOURCE MANAGEMENT (VRM): The planning, design, and implementing of management objectives to provide acceptable levels of visual impacts for all resource management activities.

WATER TABLE: The upper limit of the part of the soil or underlying rock material that is wholly saturated with water.

WEED: A plant out of place or growing where not desired.

WEED-INFESTED ACRE: Any part of an acre of land that is infested with weeds.

WILDERNESS: An area designated by Congress as part of the National Wilderness Preservation System. Wilderness areas are generally undeveloped Federal lands that retain their primeval character and influence without improvements or human habitation.

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